Boston Logan International Airport

ESPR

2017 Environmental Status and Planning Report

July 2019
EOEA #3247

SUBMITTED TO
Executive Office of Energy and Environmental Affairs, MEPA Office

SUBMITTED BY
Massachusetts Port Authority
Strategic & Business Planning

PREPARED BY
vhb

IN ASSOCIATION WITH
Harris Miller Miller & Hanson
KB Environmental Sciences
ICF
Inter*VISTAS* Consulting

Boston Logan International Airport


Aircraft parked at Terminal B


Vortex Generator retrofit


Piers Park in East Boston


Massport crews clean Boston Harbor along Harborwalk

Electric vehicle charging station


Aircraft taking off from Logan Airport at sunset

ESPR

2017 Environmental Status and Planning Report

July 2019
EOEA #3247

SUBMITTED TO
Executive Office of Energy and Environmental Affairs, MEPA Office

SUBMITTED BY
Massachusetts Port Authority
Strategic & Business Planning

PREPARED BY
vhb

IN ASSOCIATION WITH
Harris Miller Miller & Hanson
KB Environmental Sciences
ICF
Inter*VISTAS* Consulting

Massachusetts Port Authority
One Harborside Drive
East Boston, MA 02128-2909
Telephone (617) 568-5000
www.massport.com

July 30, 2019
The Honorable Kathleen A. Theoharides, Secretary
Executive Office of Energy and Environmental Affairs
Attn: Anne Canaday, EEA 3247
100 Cambridge Street, Suite 900
Boston, Massachusetts 02114

Re: Boston Logan International Airport 2017 Environmental Status and Planning Report - EEA #3247

Dear Secretary Theoharides and Director Buckley:

On behalf of the Massachusetts Port Authority (Massport), we are pleased to submit this 2017 *Environmental Status and Planning Report* (ESPR) for Boston Logan International Airport. This filing continues Massport's nearly four-decade practice of providing an extensive record of Logan Airport environmental trends, facility planning, operations and passenger levels, and Massport's mitigation commitments. This ESPR focuses both on current and recent operational and environmental conditions at Logan Airport and looks forward in an effort to project likely future conditions over the next 10-15+ years. Fundamental to this analysis is a new set of aviation forecasts that look both at the drivers of Logan Airport's recent and future growth as well as the likely changes in passenger levels, annual aircraft operations, aircraft fleet, and how both passengers and employees get to and from Logan Airport.

The recent growth at Logan Airport is attributed to the strong local, regional, and national economies and its role as the major airport to a region that is the home to world-class educational and medical institutions, cutting-edge technology companies, rich historical resources, and extensive tourism. It is within this context that Logan has experienced significant growth. Like elsewhere throughout the metropolitan area, this growth often creates challenges; this ESPR outlines a range of operational and environmental mitigation strategies Massport is implementing to address those current and future challenges.

Consistent with the recent *Environmental Data Reports* (EDR), this ESPR focuses on a number of evolving issues including: (1) continued rapid growth in domestic and international passenger demand, (2) the effects of transportation network companies (TNC) such as Uber and Lyft on ground access, (3) Massport strategies to reduce airport-wide emissions including those associated with vehicle trips, and (4) noise abatement. A few key findings on these topics follow.

- **Passenger Growth**. Due to the regional economic conditions, passenger activity at Logan is continuing to outpace both national averages and the forecasts presented in the *2011 ESPR*. Logan has also experienced a growth in aircraft operations; however, passenger growth continues to far outpace the increase in aircraft operations. This trend supports Massport's long-standing goals to reduce overall operating and environmental impacts at Boston Logan International Airport.

- **Ground Access/TNCs**. The TNCs such as Lyft and Uber, that did not exist just a few years ago, are now significant providers of Logan Airport passenger ground access/egress. This *2017 ESPR* provides a detailed update on the status of Logan TNC operations and the measures Massport has implemented to both reduce the daily TNC trips and reinforce use of Logan's wide range of high occupancy vehicle (HOV) alternatives.

- **HOV Strategies**. For many years, Logan has had one of the highest percentages of any airport in the United States for passenger use of HOV. In addition to transit access, Massport's Logan Express system is a key reason for this high HOV utilization. Massport's strategies for doubling Logan Express ridership, including a number of measures already implemented, are outlined in Chapter 5, *Ground Access to and from Logan Airport.*

- **Emissions Reduction**. Massport has committed to a broad range of emission reduction strategies that build on long-standing programs. These include constructing and operating LEED buildings, expanding our renewable energy sources, investing in low and zero emission vehicles that complement our HOV initiatives and other energy efficiency programs. Most notable is a recent commitment to phase out over 1,000 diesel- and gas-powered ground service equipment (GSE) by 2027 (as equipment is commercially available). GSE represent one of the largest sources of airfield emissions after aircraft.
- **Noise Abatement.** As described beginning in the earliest phases of these reports, FAA and Massport implement numerous noise abatement strategies. Most recently, Massport has worked with FAA to better understand the implications of performance-based navigation (such as area navigation [RNAV]) and evaluate strategies to address community concerns. Massport has also successfully advocated for jetBlue Airways to retrofit its Airbus 320 fleet with noise-reducing "vortex generators." Both of these measures are expected to have a significant benefit in reducing aircraft noise.

The ESPR provides an update on the status of ongoing Logan Airport projects including the Terminal E Modernization Project, the Logan Airport Parking Project, other terminal and roadway projects as well as planning and environmental initiatives. Chapter 3, *Airport Planning* also previews planned and potential new projects and programs.

ESPR Content and Structure

The *2017 ESPR* responds to the Secretary's Certificate on the *Boston Logan International Airport 2016 Environmental Data Report* dated August 10, 2018. The ESPR also updates 2017 (and later where available) conditions for the following categories:

- Passenger levels, aircraft operations, aircraft fleets, and cargo volumes;
- Planning, design, and construction activities at Logan Airport;
- Regional transportation statistics and initiatives;
- Key environmental indicators (Ground Access, Noise Abatement, Air Quality/Emissions Reduction, and Environmental Compliance and Management/Water Quality);
- Status of Logan Airport project mitigation; and
- Sustainability initiatives.

The *2017 ESPR* includes the Secretary's Certificate on the *Boston Logan International Airport 2016 EDR*, the 2018 Notice of Project Change (NPC) and associated comment letters. Recent Certificates received on the Logan Airport Parking Project (EEA# 15665) and Terminal E Modernization Project (EEA# 15434), which included items to be addressed in future EDRs and the ESPR are also included. Appendix D, *Distribution* presents the ESPR distribution list and supporting technical appendices are included in the attached CD. Please note that similar to the *2012/2013 EDR*, Massport has requested the EEA Secretary's consideration of combining the 2018 and 2019 EDR; a proposed scope for a combined 2018/2019 EDR is included as Appendix C, *Proposed Scope for the 2018/2019 EDR*.

Review Period, Distribution, and Consultation

Massport has requested EEA's consideration of an *extended* 60-day public comment period for this ESPR in consideration of the summer filing date. Based on this request, the public comment period will begin on August 7, 2019, the publication date of the next MEPA *Environmental Monitor*, and will end on October 11, 2019. The distribution list included as Appendix D indicates which listed parties will receive a digital and/or printed copy of this EDR or notice of availability. As with the recent EDRs and other Massport environmental filings, this ESPR is presented in its entirety on Massport's website (http://www.massport.com/massport/about-massport/project-environmental-filings/).

A consultation session on the *2017 ESPR* is planned for late September in the Cathy Leonard-McLean Community Room on the 1st floor of the Logan Airport Rental Car Center. Details on the date of the meeting will be forthcoming. Additional copies of the *2017 ESPR* may be obtained by calling (617) 568-3546 or emailing mgove@massport.com during the public comment period.

We look forward to your review of this document and to consultation with the MEPA Office and other reviewers. Please feel free to contact me at (617) 568-3524, if you have any questions.

Sincerely,

Massachusetts Port Authority

Stewart Dalzell

Stewart Dalzell, Deputy Director
Environmental Planning & Permitting,
Strategic & Business Planning Department

cc: J. Barrera, H. Morrison, F. Leo, A. Coppola, C. McDonald, M. Gove/Massport

This Page Intentionally Left Blank.

Table of Contents

List of Appendices

List of Tables

List of Figures

Acronyms

This section provides a list of acronyms and abbreviations that are found in the *2017 ESPR*.

A

AADT	Annual Average Daily Traffic
ACI-NA	Airports Council International – North America
ACRP	Airport Cooperative Research Program
AEDT	Aviation Environmental Design Tool
AFV	Alternative Fuel Vehicle
ALP	Airport Layout Plan
APM	Automated People Mover
APU	Auxiliary Power Unit
ARFF	Airport Rescue and Fire Fighting
ASPM	Aviation System Performance Metrics
AST	Aboveground Storage Tanks
ATMS	Automated Traffic Monitoring System
AUL	Activity and Use Limitation
AVI	Automated Vehicle Identification
AWDT	Annual Average Weekday Daily Traffic
AWEDT	Annual Average Weekend Daily Traffic

B

BC	Black Carbon
BDL	Bradley International Airport, CT airport code
BED	Hanscom Field, MA airport code
BGR	Bangor International Airport, ME airport code
BIF	Bird Island Flats
BLANS	Boston Logan Airport Noise Study
BMP	Best Management Practice
BONS	Boston Overflight Noise Study
BOS	Boston Logan International Airport, MA airport code
BRT	Bus Rapid Transit
BTV	Burlington International Airport, VT airport code
BWSC	Boston Water and Sewer Commission

C

CAA	Clean Air Act
CAC	Community Advisory Committee
CACI	Clean Air Construction Initiative
CA/T	Central Artery/Tunnel
CAT III	Category III (instrument landing system)
CBP	U.S. Customs and Border Protection
CFC	Chlorofluorocarbon
CH_4	Methane

CMR Code of Massachusetts Regulations
CNG Compressed Natural Gas
CNI Cumulative Noise Index
CO Carbon monoxide
CO_2 Carbon dioxide
CONEG Conference of New England Governors
ConnDOT Connecticut Department of Transportation
CRO Converging Runway Operations
CTPS Central Transportation Planning Staff

D

dB Decibel
dBA A-weighted decibel
DFS Department of Fire Services
DIRP Disaster and Infrastructure Resiliency Planning Study
DNL Day-Night Sound Level
DPH Department of Public Health
DOT U.S. Department of Transportation

E

EA Environmental Assessment
EDR Environmental Data Report
EDMS Emissions and Dispersion Modeling System
EEA Executive Office of Energy and Environmental Affairs
eGSE Electric Ground Service Equipment
EIR Environmental Impact Report
EIS Environmental Impact Statement
EMAS Engineered Materials Arresting System
EMS Environmental Management System
ENF Environmental Notification Form
EPA U.S. Environmental Protection Agency
EPNL Effective Perceived Noise Level
EPNdB Effective Perceived Noise Level (units)
ESPR Environmental Status and Planning Report
EV Electric Vehicle

F

FAA Federal Aviation Administration
FAR Federal Aviation Regulation
FBO Fixed Base Operator
FDS Fuel Distribution System
FIS Federal Inspection Services
FONSI Finding of No Significant Impact
FRA Federal Railroad Administration
FY Fiscal Year

G

GA General Aviation
GDP Gross Domestic Product
GEIR Generic Environmental Impact Report
GHG Greenhouse Gas
GIS Geographic Information Systems

GPS	Global Positioning System
GSE	Ground Service Equipment
GTOC	Ground Transportation Operations Center
H	
HCFC	Hydrochlorofluorocarbon
HOV	High Occupancy Vehicle
HVAC	Heating, Ventilation, and Air Conditioning
HVN	Tweed New Haven Airport, CT airport code
Hz	Hertz
I	
IATA	International Air Transport Association
ICAO	International Civil Aviation Organization
ILS	Instrument Landing System
INM	Integrated Noise Model
IPCC	Intergovernmental Panel on Climate Change
ISA	Inclined Safety Area
ISO	International Organization for Standardization
J	
JFK	John F. Kennedy International Airport, NY airport code
JOC	Joint Operations Center
K	
kBTU	Thousand British Thermal Units
kg	Kilogram
kWh	Kilowatt-hours
L	
lbs	Pounds
LCC	Low-Cost Carriers
LDMS	Logan Dispersion Modeling System
LED	Light-Emitting Diode
LEED®	Leadership in Energy and Environmental Design
LTO	Landing and Takeoff
M	
M.G.L.	Massachusetts General Laws
MAPC	Metropolitan Area Planning Council
MassDEP	Massachusetts Department of Environmental Protection
MassDMF	Massachusetts Division of Marine Fisheries
MassDOT	Massachusetts Department of Transportation
Massport	Massachusetts Port Authority
MBTA	Massachusetts Bay Transportation Authority
MCP	Massachusetts Contingency Plan
MEPA	Massachusetts Environmental Policy Act
MHT	Manchester-Boston Regional Airport, NH airport code
MIT	Massachusetts Institute of Technology
MMT	Million Metric Tons
MOA	Memorandum of Agreement
MOU	Memorandum of Understanding
MOVES	Motor Vehicle Emission Simulator
MPO	Metropolitan Planning Organization
mph	Miles per hour

N

NAAQS	National Ambient Air Quality Standards
NCA	North Cargo Area
NEC	Northeast Corridor
NEG/ECP	Conference of New England Governors and Eastern Canadian Premiers
NEPA	National Environmental Policy Act of 1969
NERASP	New England Regional Airport System Plan
NHESP	Natural Heritage and Endangered Species Program
NO_2	Nitrogen dioxide
NOMS	Noise and Operations Monitoring System
NO_x	Nitrogen oxides
NPC	Notice of Project Change
NPDES	National Pollutant Discharge Elimination System
NPSI	Noise Per Seat Index
NSA	North Service Area

O

O_3	Ozone
ORH	Worcester Regional Airport, MA airport code
O&D	Origin and Destination

P

PAH	Polycyclic Aromatic Hydrocarbon
PARC	Parking and Revenue Control
PARTNER	Partnership for Air Transportation Noise and Emissions Reduction
Pb	Lead
PBN	Performance-Based Navigation
PCA	Pre-Conditioned Air
PM	Particulate Matter (e.g., PM_{10}, $PM_{2.5}$)
ppm	Parts per million
PRAS	Preferential Runway Advisory System
PSM	Portsmouth International Airport at Pease, NH airport code
PVD	T.F. Green Airport, Warwick RI airport code
PWM	Portland International Jetport, ME airport code

Q

QTA	Quick Turnaround Areas

R

RACT	Reasonably Available Control Technology
RAM	Release Abatement Measure
RAO	Response Action Outcome
RCC	Rental Car Center
RIAC	Rhode Island Airport Corporation
RIDOT	Rhode Island Department of Transportation
RIM	Runway Incursion Mitigation
RJ	Regional Jet
RNAV	aRea Navigation
ROD	Record of Decision
RPZ	Runway Protection Zone
RSA	Runway Safety Area
RSIP	Residential Sound Insulation Program
RTC	Regional Transportation Center

S

SCA	South Cargo Area
SDSG	Sustainable Design Standards and Guidelines
SIP	State Implementation Plan
SMP	Sustainability Management Plan
SO_2	Sulfur dioxide
SOV	Single Occupancy Vehicle
SPCC	Spill Prevention Control and Countermeasure Plan
SPL	Sound Pressure Level
SRE	Snow Removal Equipment
STEM	Science, Technology, Engineering, and Mathematics
SWPPP	Stormwater Pollution Prevention Plan
SWSA	Southwest Service Area

T

TA	Time Above
TAF	Terminal Area Forecast
TDM	Transportation Demand Management
TIM	Time-in-Mode
TMA	Transportation Management Association
TNC	Transportation Network Company
tpy	Tons per year
TRB	Transportation Research Board
TSA	Transportation Security Administration
TSS	Total Suspended Solids

U

UAS	Unmanned Aircraft Systems
UFP	Ultrafine Particles
ULCC	Ultra Low-Cost Carriers
USC	United States Code
USGBC	U.S. Green Building Council
UST	Underground Storage Tank

V

VALE	Voluntary Airport Low Emissions Program
VMT	Vehicle Miles Traveled
VOC	Volatile Organic Compounds

Other

$\mu g/m^3$	Micrograms of pollutant per cubic meter
μm	Micrometers

This Page Intentionally Left Blank.

1

Introduction/Executive Summary

Introduction

The Massachusetts Port Authority (Massport) is continuing its over three-decade practice of providing an extensive record of Boston Logan International Airport (Logan Airport or Airport) environmental trends, facility planning, operations and passenger levels, and Massport's mitigation commitments in this *Boston Logan International Airport 2017 Environmental Status and Planning Report (ESPR)*.

Logan Airport, owned and operated by Massport, plays a key role in the metropolitan Boston and New England passenger and freight transportation networks; it is the primary airport serving the Boston metropolitan area, the principal New England airport for long-haul services, and a major U.S. international gateway airport for transatlantic services. The Airport boundary encompasses approximately 2,400 acres in East Boston and Winthrop, including approximately 700 acres in Boston Harbor. Logan Airport's airfield comprises six runways, approximately 15 miles of taxiway, and approximately 240 acres of concrete and asphalt apron. Logan Airport has four interconnected passenger terminals (Terminals A, B, C, and E), each with its own ticketing, baggage claim, and ground transportation facilities. The Airport is less than a three-mile drive from downtown Boston and is accessible by two public transit lines, five direct bus lines, and a well-connected roadway system. Massport provides Logan Express bus service to and from Logan Airport for air passengers and employees from park-and-ride lots in Braintree, Framingham, Woburn, and Peabody; Massport also provides urban Logan Express service from Boston's Back Bay area.

This *2017 ESPR* is one in a series of annual environmental review documents submitted to the Secretary of the Executive Office of Energy and Environmental Affairs (EEA), in accordance with the Massachusetts Environmental Policy Act (MEPA).[1] Since 1979, Massport has submitted these documents to report on the cumulative environmental effects of Logan Airport's operations and activities. Logan Airport is the first airport in the nation for which an annual environmental assessment on airport activities was prepared, and Massport continues to be a leader in environmental reporting.

Approximately every five years, Massport prepares an ESPR, which provides a historical and prospective view of Logan Airport. Environmental Data Reports (EDRs), prepared annually in the intervals between ESPRs, provide a review of environmental conditions for the reporting year compared to the previous year. This *2017 ESPR* follows the *2016 EDR* and reports on 2017 and future conditions.

1 Massachusetts General Laws Chapter 30, Sections 61-62H. MEPA is implemented by regulations published at 301 Code of Massachusetts Regulations (CMR) 11.00 ("the MEPA Regulations").

The scope for this document was established by the Secretary's Certificate dated March 9, 2018, which is included in Appendix A, *MEPA Certificates and Responses to Comments*. This *2017 ESPR* fulfills all the requirements laid out in the Secretary's 2018 Certificate. This *2017 ESPR* provides detailed responses to comments on the Secretary's Certificate and updates and compares the data presented in the *2016 EDR* for the following subjects:

- Activity Levels (including aircraft operations, passenger activity, and cargo volumes)
- Airport Planning (including activities underway and upcoming projects)
- Logan Airport's Role in the Regional Transportation Network
- Ground Access to and from the Airport
- Future forecasts for aircraft operations and passenger activity and modeled future ground access, noise, and air quality conditions
- Noise Abatement
- Air Quality/Emissions Reduction
- Water Quality/Environmental Compliance
- Sustainability and Resiliency
- Environmentally Beneficial Measures and Mitigation Commitments

To enhance the usefulness of this *2017 ESPR* as a reference document for reviewers, this report also presents historical data on the environmental conditions at Logan Airport dating back to 1990, in instances where historical information is available. When appropriate and available, the *2017 ESPR* also includes updates through 2018.

This *2017 ESPR* includes a Spanish translation of the Executive Summary. This translated version is included after the English-version of the Executive Summary.

EEA # 3247

Submitted By

Massachusetts Port Authority
One Harborside Drive, Suite 200S
East Boston, MA 02128

Stewart Dalzell, Deputy Director
Strategic & Business Planning
(617) 568-3524

Michael Gove, Project Manager
Strategic & Business Planning
(617) 568-3546

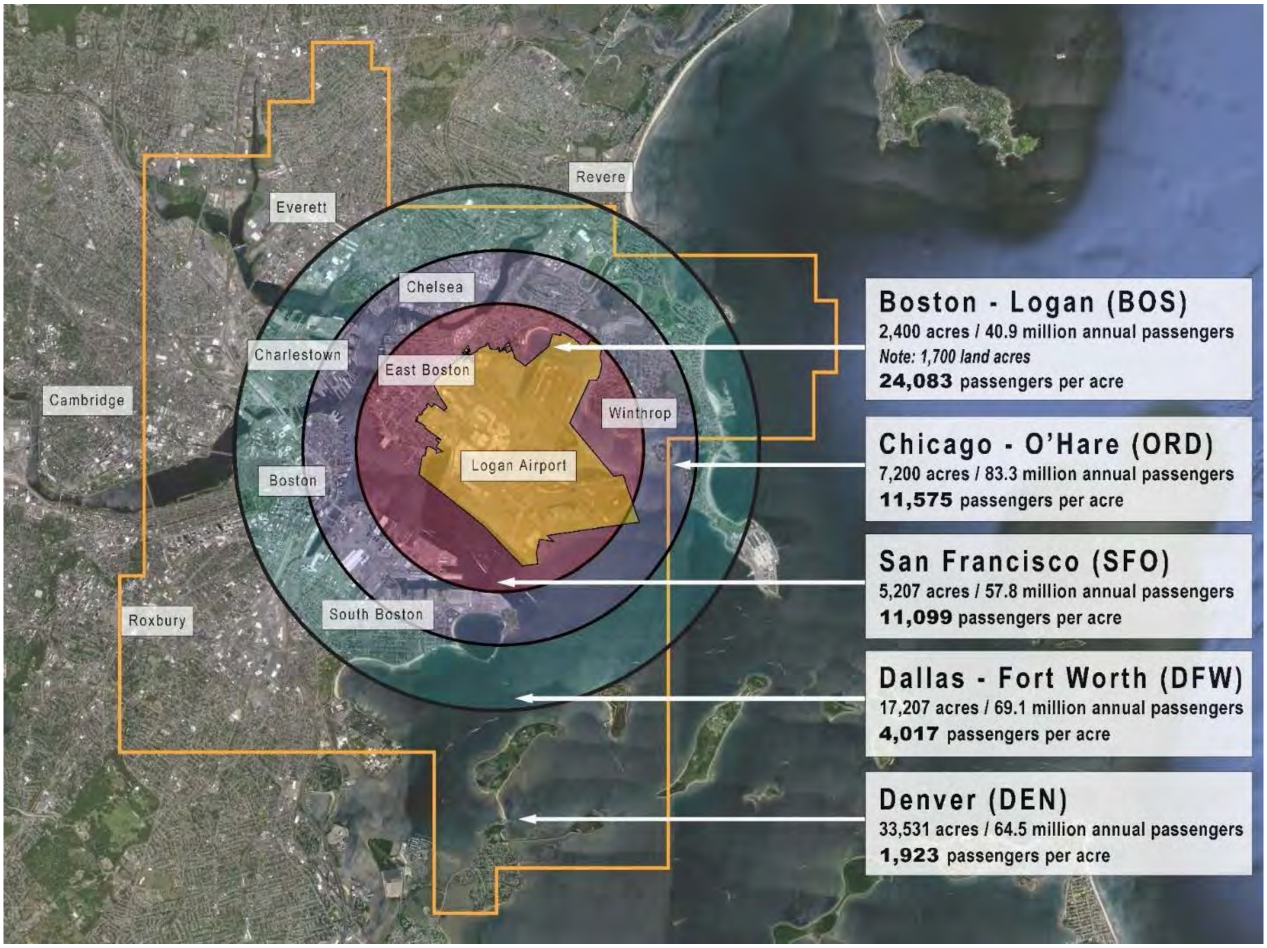
Logan Airport Planning Context

Logan Airport plays a key role in the metropolitan Boston and New England passenger and freight transportation networks. The Airport is one of the most land-constrained airports in the nation and is surrounded on three sides by Boston Harbor (see **Figures 1-3** and **1-4**). As shown in **Figure 1-2**, Logan Airport could fit 14 times within the boundary of Denver International Airport.

Figure 1-1 Logan Airport Rankings, 2017

Source: ACI, 2017; U.S. Department of Transportation T-100 Database, 2017.
Note: A U.S. international passenger gateway refers to a U.S. port of entry for passengers traveling internationally. Logan Airport ranks 12th among other U.S. airports with international service, in terms of total number of international enplaned passengers.

Figure 1-2 Logan Airport and Other International Airports Size Comparison



Source: ACI, 2018 North American Airport Traffic Summary (Passenger); Massport.

FIGURE 1-3 Aerial View of Logan Airport

2017 Environmental Status and Planning Report

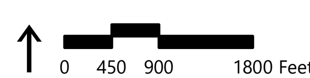


FIGURE 1-4 Logan Airport and Environs

2017 Environmental Status and Planning Report

Passenger and Aircraft Activity Growth at Logan Airport

In 2017, air passenger activity levels at Logan Airport reached an all-time high of 38.4 million, an increase of 5.9 percent over 2016. Aircraft operations increased at a slower rate, totaling 401,371 in 2017, an increase of 2.6 percent over 2016. This trend continued in 2018 with air passenger activity levels of 40.9 million and aircraft operations totaling 424,024 (**Figure 1-5**). The growth is directly correlated to the strong national and regional economies. Aircraft operations remain well below the 487,996 operations in 2000 and the historic peak of 507,449 operations reached in 1998 (**Figure 1-6**). The slower growth in aircraft operations compared to passenger levels is due to the steady increase in aircraft size and improving aircraft load factors (passengers/available seats).

Figure 1-5 Logan Airport Annual Passenger Levels Continue to Grow Faster than Aircraft Operations (1990–2018)

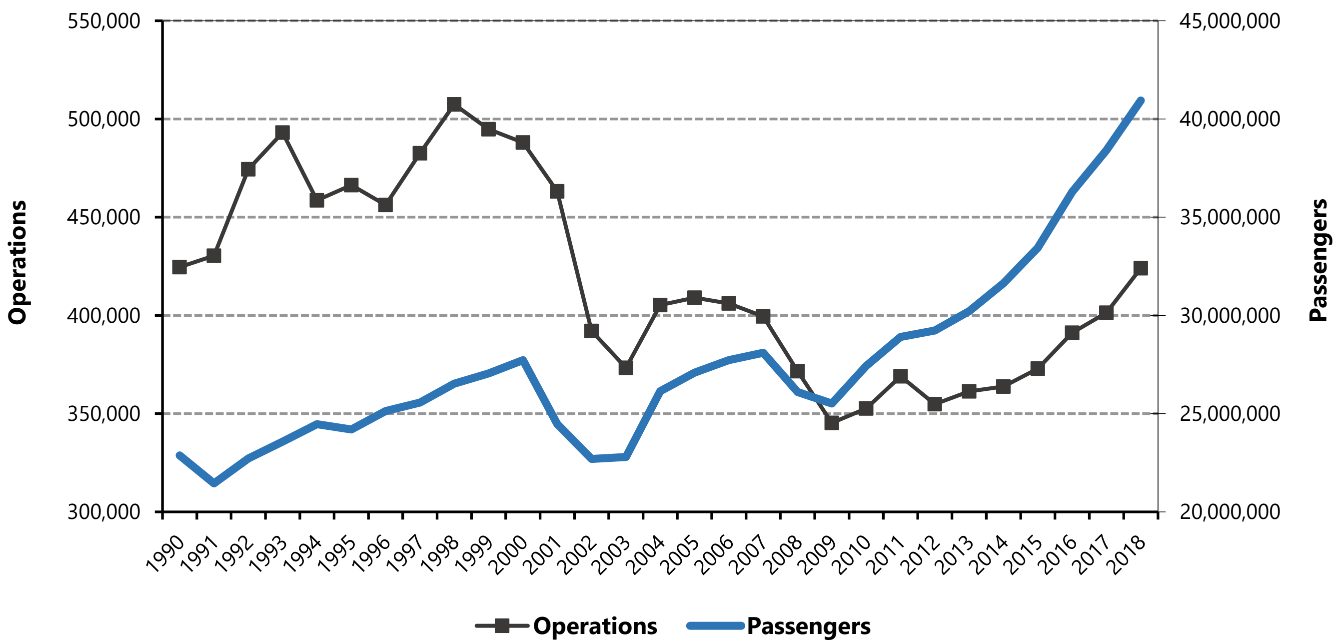


Figure 1-6 Logan Airport Annual Passengers and Operations, 1990, 1998, 2000, 2016–2018

Strong Regional Economy Drives Growth at Logan Airport

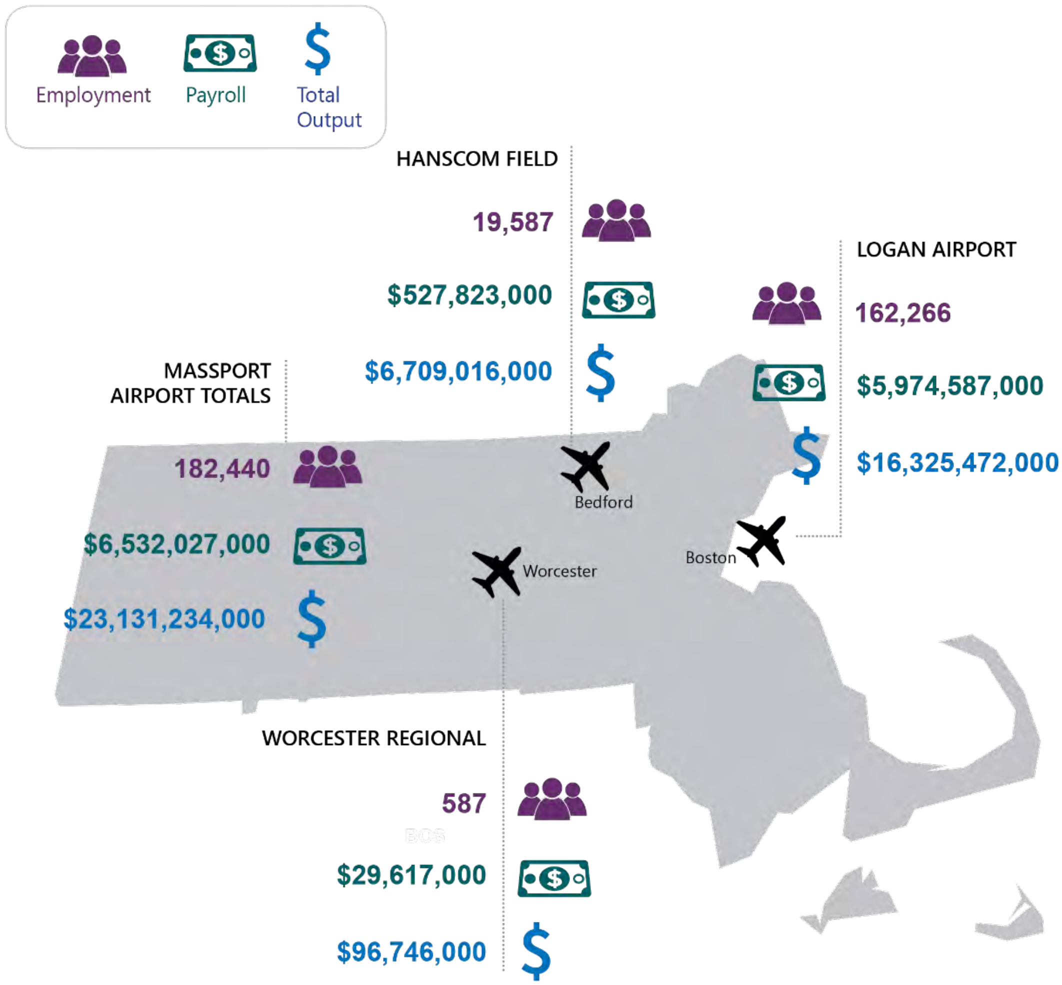
Growth at Logan Airport can be attributed to the strong local, regional, and national economies. With this growth comes challenges, and Massport has a strategy to address these challenges in a manner that will allow Logan Airport to evolve in a sustainable and environmentally-responsible way.

Logan Airport is the largest airport in the six-state New England region, which has a population of approximately 14.8 million residents. The Airport is located in Massachusetts, which is home to 6.8 million residents, or 47 percent of the total population of New England. The Airport serves passengers from across New England, with its primary catchment area consisting of five Massachusetts counties: Essex, Middlesex, Norfolk, Plymouth, and Suffolk (which includes the City of Boston). According to the most recently available statistics, 4.4 million people reside in this five-county area, and population within the catchment area is projected to increase by 0.5 percent per year over the next 19 years.[2] The Boston metropolitan area has consistently maintained a lower unemployment rate (3.4 percent) than that of the Commonwealth (3.7 percent) and the entire country (4.4 percent).[3] The Airport not only serves a growing population, but a high earning one as well. Per capita income in 2017 was $65,941 (2009 U.S. dollars) in the Airport's primary service area, 11.2 percent higher than the Commonwealth and 45.5 percent higher than the national average.[4]

Logan Airport is a key transportation and economic resource in the New England region, the state, and the Boston metropolitan area, which is home to a broad range of industries. The industries accounting for the largest share of employees include: healthcare and social assistance; educational services; and professional, scientific, and technology services (which include Boston's growing biotech industry).[5] In 2017, Boston was declared the "#1 city in the U.S. for fostering entrepreneurial growth and innovation."[6] The contribution of innovation and business start-ups is also evident in the latest 2017 year-to-date economic growth estimates and reflects trends in increased employment and high-tech industries.

2 Woods & Poole Economics, Inc. 2018. Complete Economic and Demographic Data Source (CEDDS).
3 U.S. Bureau of Labor Statistics. 2017.
4 Woods & Poole Economics, Inc. 2018.
5 U.S. Census Bureau via DataUSA. Boston-Cambridge, Newton, MA-NH Metro Area profile. wwww.datausa.io.
6 U.S. Chamber of Commerce Foundation and 1776. 2017. *Innovation That Matters*.

Figure 1-7 Total Economic Impact of Massport Airports



Source: MassDOT, Massachusetts Statewide Airport Economic Impact Study Update, 2019.
Notes: "Massachusetts Totals" refers to the total economic output of all Massachusetts airports.

In addition to supporting the growth and economic success of the state, Logan Airport and the airport industry are important elements in the state and regional economy. The *Massachusetts Statewide Airport Economic Impact Study Update,* completed by the Massachusetts Department of Transportation (MassDOT) in 2014 and most recently updated in 2019,[7] estimates that Massport airports contribute approximately $23.1 billion in output to the Massachusetts economy annually; of this output, 71 percent is due to Logan Airport alone.[8] Total output includes on-Airport businesses, construction, visitor, and

7 MassDOT. 2014. *Massachusetts Statewide Airport Economic Impact Study Update*. http://www.massdot.state.ma.us/portals/7/docs/airportEconomicImpactSummary.pdf.

8 *Ibid*.

multiplier effects (see **Figure 1-7**).[9] Logan Airport supports over 162,000 direct and indirect jobs, while generating approximately $16.3 billion per year in total economic output.[10] In 2017, over 20,000 people were employed at Logan Airport. This included approximately 1,285 Massport airport staff and administrative employees.[11]

Logan Airport is considered an origin and destination (O&D)[12] airport both nationally and internationally, meaning that approximately 90 percent of Logan Airport passengers either start or end their trip in the New England area. Hub airports, such as Atlanta or Chicago, serve many more passengers annually but, compared to O&D airports like Logan Airport, a higher percentage of passenger traffic at hub airports passes through to connecting flights. Logan Airport is one of the fastest growing large airports in the U.S., in terms of number of passengers, over the past five years.[13] In 2017, U.S. air passenger traffic grew by 3.5 percent, whereas Logan Airport experienced a passenger growth of 5.9 percent.[14] International air passengers contribute a substantially higher share to the local and regional economy than domestic passengers. In 2017, Logan Airport welcomed 1.6 million overseas visitors, a 4.8-percent increase over 2016 levels.[15] New international service in the last five years alone has contributed more than $1.3 billion per year to the local economy and $49 million in new incremental income and sales tax revenue.[16]

OVER THE YEARS, THE REGIONAL ECONOMY AND THE KNOWLEDGE SHARING IN THE INFORMATION TECHNOLOGY, LIFE SCIENCES, FINANCE, EDUCATION, AND HEALTHCARE INDUSTRIES HAVE SPURRED THE INCREASE IN THE NUMBER OF PASSENGERS AT LOGAN AIRPORT. THE EXPANSION OF INTERNATIONAL ROUTES SUPPORTS THE ECONOMIC OPPORTUNITIES MASSACHUSETTS HAS BY ENABLING IT TO REACH DOZENS OF MARKETS THROUGHOUT THE WORLD AND IMPROVING COMPETITIVENESS AS A TOP-TIER GLOBAL LOCATION FOR BUSINESS, RESEARCH, EDUCATION, TECHNOLOGY, AND TOURISM.

Source: *Mass*Benchmarks. 2018. *The Journal of the Massachusetts Economy, Volume 20 Issue 2*.

9 Multiplier effects refer to the recirculation of money in the local economy after initially being spent by the Airport, its tenants, or tourists. This recirculation increases the overall impact of the Airport's operation in the local economy.

10 MassDOT Aeronautics Division. 2019. *Massachusetts Statewide Airport Economic Impact Study Update*. https://www.mass.gov/files/documents/2019/03/25/AeroEcon_ImpactStudy_January2019.pdf.

11 Massport, 2018. *Massachusetts Port Authority 2018 Comprehensive Annual Final Report*. https://www.massport.com/media/3029/mpa-fy18-cafr-final.pdf. Table S-11.

12 "Origin and destination" traffic refers to the passenger traffic that either originates or ends at a particular airport or market. A strong O&D market like Boston generates significant local passenger demand, with many passengers starting their journey and ending their journey in that market. O&D traffic is distinct from connecting traffic, which refers to the passenger traffic that does not originate or end at the airport but merely connects through the airport en route to another destination.

13 Between 2012 and 2017, Logan Airport was the 9th fastest growing airport in the U.S. in terms of domestic O&D traffic (U.S. DOT O&D Survey).

14 ACI. 2017. ACI North American Airport Traffic Summary. http://www.aci-na.org/content/airport-traffic-reports.

15 Greater Boston Convention and Visitors Bureau. 2018. Overseas Visitation. https://www.bostonusa.com/media/statistics-reports/overseas-visitation/.

16 InterVISTAS. 2016. *Economic Impact of Recent International Routes*.

Future Planning Horizon

As part of its ongoing strategic planning effort, Massport prepares aircraft operations and passenger activity level forecasts every few years. This ESPR evaluates future operational and environmental conditions associated with a projected 50 million annual air passengers and 486,000 annual aircraft operations in the next 10 to 15 years (the Future Planning Horizon). Massport's forecast is consistent with the Federal Aviation Administration's (FAA's) Terminal Area Forecast.

Massport Investment in Logan Airport

Massport is committed to evaluating and implementing enhancements to Logan Airport's safety, security, operational efficiency, and accessibility to and from the Boston metropolitan area, while carefully monitoring the environmental effects of Logan Airport operations. Massport is continually improving the facilities at Logan Airport.

Massport is currently focused on enhancing the passenger and user experience at Logan Airport in all aspects of the facility. Recent and ongoing terminal area projects are providing seamless post-security connectivity among the terminals along with enhancements to passenger processing through consolidated security checking areas. Access to and around Logan Airport is the next critical area of improvement.

To improve accessibility to the Airport as well as to relieve on-Airport roadway congestion, Massport continues to enhance high-occupancy vehicle (HOV) and Logan Express facilities, implement on-Airport roadway and Massachusetts Bay Transportation Authority (MBTA) Blue Line/intra-terminal connectivity projects, construct a consolidated transportation network company (TNC, such as Uber and Lyft) drop-off and pick-up area, and construct new parking facilities, which will help reduce the number of drop-off/pick-up trips. Massport continues to work with the FAA to enhance airside safety through a variety of runway safety area (RSA) improvements and simplification of the airfield geometry.

Massport's Strategy to Manage Current and Future Environmental Conditions

Massport understands its role as owner and operator of Logan Airport and steward of the environment. This *2017 ESPR* documents the current conditions at the Airport and, based on forecast passenger and aircraft operations activities, models future conditions and outlines Massport's plans to responsibly manage growth at the Airport while minimizing environmental impacts.

Massport's strategy to minimize impacts is a combination of:

- Policy initiatives and infrastructure improvements;
- Sustainability and resiliency investments; and
- Community support and partnerships.

As noted above, due to the strong economy, passenger activity levels and aircraft operations at Logan Airport have been increasing and are projected to continue this trend through the Future Planning Horizon, potentially reaching 50 million annual air passengers in the next 10 to 15 years.

The success of Worcester Regional Airport is helping to accommodate this regional economic growth and demand for air travel. Worcester Regional Airport saw passenger numbers increase 32 percent in 2018 compared to 2017 and reported a total of approximately 600,000 passengers from 2013 to 2018. In the past five years, Worcester Regional Airport has experienced an average growth rate of 30 percent per year. Massport continues to invest in Worcester Regional Airport—together with the City of Worcester, Massport has already initiated a $100 million, 10-year investment to revitalize and attract commercial operations to Worcester Regional Airport. Investments include a Category (CAT) III Instrument Landing System (about $32 million) paid for by federal grants and Massport funds. Additionally, jetBlue Airways, American Airlines, and Delta Air Lines announced new service to New York John F. Kennedy International Airport (JFK), Philadelphia International Airport, and Detroit Metropolitan Wayne County Airport, respectively.

Massport's strategy to manage the growth of Logan Airport in an environmentally responsible manner focuses on initiatives within Massport's control or influence. For example, the majority of environmental impacts associated with Logan Airport are from aircraft operations and associated activities, which Massport cannot control but strives to influence.

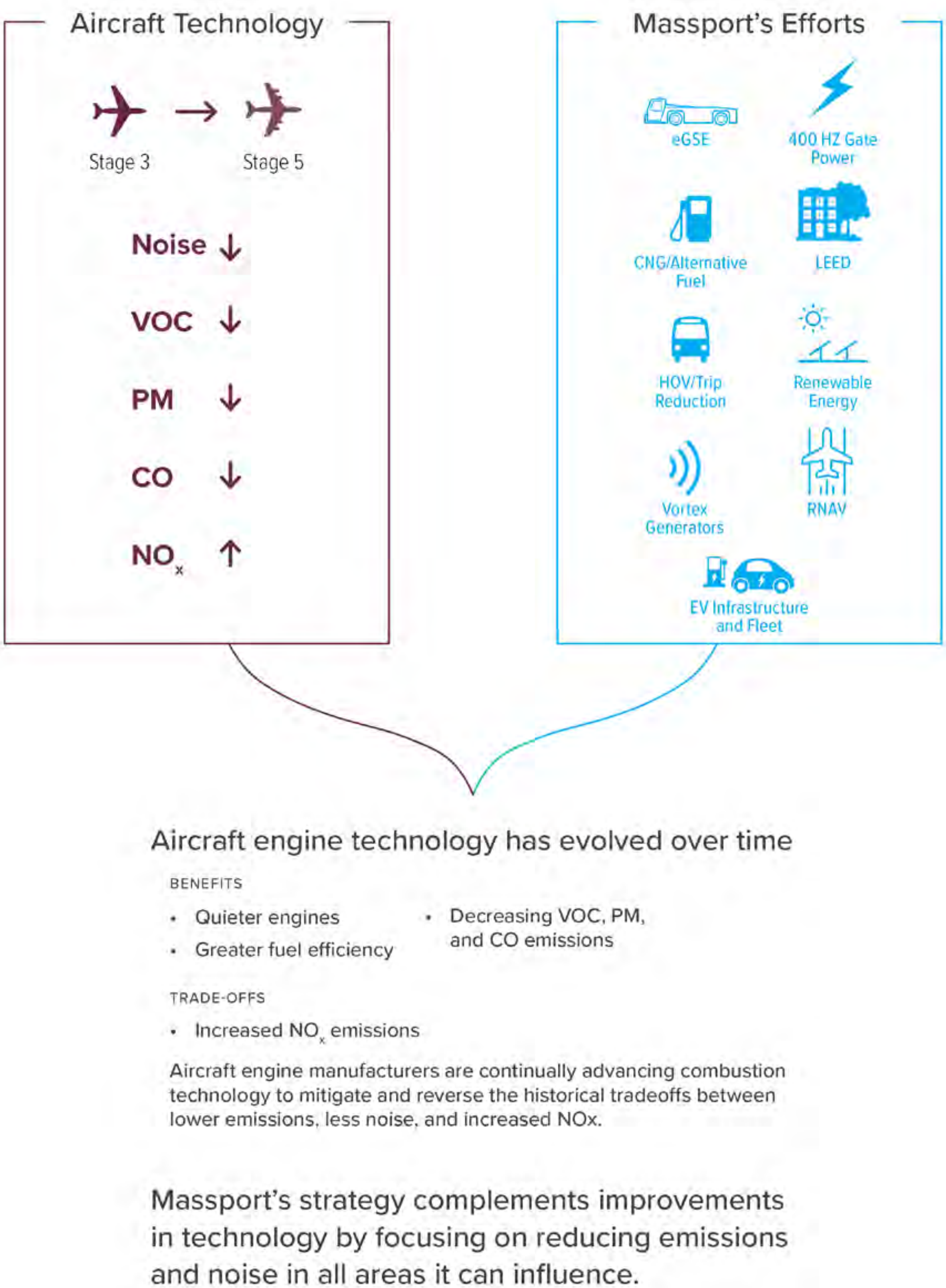
The sections that follow highlight Massport's strategy and successes for air quality, ground access, and noise abatement, as well as its sustainability program. Sustainability initiatives throughout this report are highlighted with a sustainability leaf.

Table 1-1 provides a summary of key environmental conditions at Logan Airport in 2017 and anticipated future conditions and documents Massport's planned approach to limit effects on the environment and community.

Table 1-1 Summary of Key Environmental Conditions, 2017 and Future Planning Horizon and Massport's Strategy

Environmental Category	2017	Future Planning Horizon	Massport's Strategy
Ground Access	▪ Average daily traffic and vehicle miles traveled (VMT) on Airport roadways increases. ▪ Transportation Network Companies (TNCs), such as Uber and Lyft, are impacting other access modes and contributing to off- and on-Airport congestion.	▪ Recognizing current challenges, Massport plans to continue implementing transportation policy changes and infrastructure modifications, with the goal of decreasing total daily VMT on-Airport.	▪ Commit to reducing congestion and associated emissions by increasing high-occupancy vehicle (HOV) ridership, reducing TNC deadheading activity (empty one-way trips), increasing on-Airport parking to reduce drop-off/pick-up, and expanding Logan Express service and facilities. ▪ Evaluate and implement on-Airport infrastructure improvements to reduce congestion.
Noise	▪ The Day-Night Average Sound Level (DNL) contour increased. ▪ The total number of people residing in the DNL 65 dB contour increased by 483 people, from 7,450 in 2016 to 7,933 in 2017. ▪ The total number of people residing in the DNL 65 dB contour in 2017 is about 82 percent lower than 1990 numbers, due to improved engine technology.	▪ The DNL 65 dB contour is projected to increase modestly due to expected growth in operations. The total number of people residing in the DNL 65 dB contour would also increase. This growth is in areas already sound-insulated by Massport or eligible for sound insulation in the past. ▪ The total number of people residing in the DNL 65 dB contour is projected to be about 81 percent lower in the Future Planning Horizon, compared to 1990.	▪ Continue to work with the Federal Aviation Administration (FAA) to better understand the implications of performance-based navigation (such as area navigation [RNAV]) and evaluate strategies to address community concerns. ▪ Continue to seek FAA funding for soundproofing eligible residences. ▪ Continue to implement noise abatement measures, such as runway use restrictions and reduced-engine taxiing. ▪ Coordinate with stakeholders through the Massport Community Advisory Committee to identify opportunities to reduce noise.
Air Quality	▪ Modeled emissions of volatile organic compounds (VOC), carbon monoxide (CO), and particulate matter (PM10/PM2.5) decreased in 2017 compared to 2016. Modeled emissions of oxides of nitrogen (NO_x) increased over the same time period, due largely to differences in aircraft fleet mix and increases in the number of landings and takeoffs (LTOs) and taxi times. Greenhouse gas (GHG) emissions also increased from 2016 to 2017.	▪ Emissions of VOC, CO, and PM10/PM2.5 are projected to decrease. NO_x emissions are projected to increase due to the changing aircraft fleet (i.e., greater use of quieter but higher NO_x emitting aircraft) coupled with the forecasted increase in aircraft operations at the Airport. GHG emissions are projected to increase.	▪ Replace gas- and diesel-powered ground service equipment (GSE) with all-electric GSE (eGSE) by the end of 2027 (as commercially available). ▪ Implement additional initiatives to increase HOV use, continue to reduce emissions from Massport fleet vehicles, and encourage use of alternative fuel vehicles. ▪ Continue to implement energy efficiency projects, including upgrades to the Central Heating and Cooling Plant, and increase the use of renewable energy, such as solar and wind installations, at the Airport.

Figure 1-8 Aircraft Engine Technology Has Evolved Over Time



Air Quality Strategy

Total emissions from all sources associated with Logan Airport are less than they were a decade ago, with the exception of NO_x. This long-term downward trend is consistent with Massport's longstanding objective to accommodate the demands of increasing passenger and cargo activity levels with fewer aircraft operations and reduced emissions wherever possible. When compared to 2016, the changes in air emissions in 2017 are well within expected values given the corresponding upturn in aircraft operations.

Effect of Aircraft Engine Technology on NO_x

Aircraft emissions continue to represent the largest source (94 percent) of NO_x at Logan Airport, followed by other sources (3 percent), ground service equipment (GSE) (2 percent), and motor vehicles (1 percent). This is an important distinction, as Massport does not have any control over aircraft emissions, which is the vast majority of the total.

As a means of reducing amounts and costs of fuel use, aircraft engine designers and manufacturers are producing more "fuel-efficient" (i.e., less fuel-burning) engines. This is achieved by enhancing engine performance with improved fuel combustion technologies, greater thrust-generating power, and less engine wear. Aircraft are also being designed to decrease fuel-burn with advancements in aircraft wing and body aerodynamics, light-weight alloy materials, and improved means of navigation. These emerging technologies and reduced fuel burn are expected to reduce emissions, reduce noise, and moderate the growth in NO_x emissions into the future.

Since Massport does not have direct control over aircraft operations or fleet choices by the airlines, it continues to focus on areas it controls in order to maximize the reduction of emissions from those sources it has an opportunity to influence. Massport's air quality management strategy for Logan Airport focuses on decreasing emissions from Airport-related sources, in addition to furthering innovative means to achieve emissions reductions Airport-wide. Massport has established a number of goals and objectives to address air emissions from Airport operations, including the minimization of Airport-related emissions through the reduction of GSE and Massport vehicle fleet emissions. Massport is focused on the following initiatives:

- **Provide infrastructure and encourage practices that support reductions in aircraft emissions**
  - Massport provides pre-conditioned air (PCA) and 400 Hertz (Hz) power at all aircraft contact gates to reduce aircraft idling and auxiliary power unit (APU) use when not enough gates are available.
  - Massport encourages single engine taxiing procedures by the airlines to reduce both noise and air emissions.
  - Use of battery powered tugs and belt loaders for the Delta Air Lines ground service fleet at Terminal A.

- **Maximize use of HOV and reduce single occupancy vehicle trips, particularly drop-off/pick-up trips, and passenger use of private vehicles to and from the Airport**
  - Massport implements an extensive HOV strategy and ground transportation improvements (see following section, Ground Access Strategy, for details).
- **Reduce emissions from fleets operating at Logan Airport**
  - Massport is facilitating the replacement of gas- and diesel-powered GSE with all-electric GSE (eGSE) by the end of 2027 (as commercially available). In 2018, the U.S. Environmental Protection Agency (EPA) awarded a $541,817 grant to Massport to replace gas- and diesel-powered GSE at Logan Airport. This grant will be used in conjunction with an FAA VALE grant Massport received in the fall of 2018 to install eGSE charging stations as part of the Terminal B Optimization Project.
  - Massport continues operation of its "Clean-Air-Cab" incentive program for alternative fuel vehicles (AFVs).
- **Provide infrastructure to support alternative fuels including compressed natural gas (CNG) and electricity**
  - Massport continues to operate one of New England's largest retail CNG stations, which is open to the public. In 2017, the CNG station pumped approximately 25,234-gallon equivalents per month for all Massport fleet vehicles (non-Massport vehicles were also using CNG).
  - Massport supports the current and future standard systems for plug-in electric vehicles (EVs). For example, the Rental Car Center (RCC) in the Southwest Service Area (SWSA) includes the infrastructure necessary to accommodate future plug-in stations for EVs.
  - Massport has installed 13 EV-charging stations to accommodate a total of 26 vehicles in the Central Garage and Terminal B parking areas. Massport commits to increasing the availability of EV charging stations so that 150 percent of this demand is available at all facilities at all times.
  - Currently, there are 64 charging stations installed at Logan Airport and its Logan Express sites, with 62 additional stations planned to be installed by 2020.
- **Reduce emissions from Massport fleet vehicles**
  - Massport continues to run and augment its fleet of 54 AFV/alternative power vehicle (APV) on-Airport shuttle buses. Massport also established a vehicle procurement policy in 2006 that requires consideration of AFVs when purchases are made.
- **Reduce emissions associated with Massport buildings, including energy needs**
  - Massport has committed to achieving Leadership in Energy and Environmental Design (LEED®) certification for eligible buildings, as appropriate.
  - Massport continues to invest in renewable energy installations on-Airport (solar/wind).

Ground Access Strategy

A key Massport focus is addressing on-Airport roadway congestion with a combination of policy changes and infrastructure improvements. The importance of alleviating congestion is twofold: it is necessary to allow for continued safe and efficient operation of the Airport's landside operations and it is necessary to reduce environmental impacts. Enhancing multimodal transportation options and providing modern, flexible infrastructure is one way an airport can reduce greenhouse gas (GHG) emissions and improve its environmental footprint.

Massport recognizes the various ways to get to and from the Airport and has a strategic plan to increase HOV mode share to 40 percent by 2027. Additionally, managing the growth in TNCs is essential to accommodate on-Airport traffic volume and promote HOV services. Potential emissions reductions are one reason why Massport is committed to a long-term goal to promote and support public and private HOV and shared-ride services aimed at serving air passengers, Airport users, and employees. Other benefits include:

- Reducing congestion on the terminal roadways and curbside drop-off/pick-up areas;
- Alleviating constraints on limited parking facilities; and
- Customer service (providing a range of transportation options for different traveler demographics).

The initiatives described below will improve roadway operations as well as air quality emissions. It is envisioned that these changes will allow Massport to reduce vehicle miles traveled (VMT) in the future despite increasing passenger activity levels. The following policy changes are anticipated:

- **Suburban Logan Express Service Enhancements**
  - Increase Braintree Logan Express service from two to three trips per hour (implemented in May 2019).
  - Add about 1,000 additional spaces to the Framingham garage.
  - Build up to 3,000 structured parking spaces at the Braintree site that is nearing capacity.
  - Provide security line priority status to Logan Express Back Bay riders (implemented in May 2019).
  - Execute sustained marketing campaign to support Logan Express strategy and increase ridership.
  - Implement Logan Express electronic ticketing.
  - Evaluate new Logan Express suburban locations, with a plan to open at least one new site.
  - Explore TNC Last Mile connections.[17]
  - Rebrand Logan Express sites as remote terminals.
  - Continue to monitor parking capacity at all Logan Express sites.

17 Individuals who fall within the 0.5-mile to 1-mile drive distance of a Logan Express facility are the most likely group to use TNCs to connect between the facility and their home.

- **MBTA Silver Line**
  - Eight Silver Line buses were purchased in 2005 by Massport and are operated by the MBTA with Massport paying operating costs. Massport plans to purchase eight additional Silver Line buses, bringing its total to 16 buses, to increase frequency.
- **Urban Logan Express Service**
  - Change pick-up/drop-off location from Copley to Back Bay Station (implemented in 2019).
  - Discount one-way fare from $7.50 to $3.00 (implemented in May 2019).
  - Free service from Logan Airport (implemented in early 2019).
  - Pilot priority security line status for riders (implemented in 2019).
  - Execute marketing campaign to support increased ridership (ongoing).
  - Implement Logan Express electronic ticketing.
  - Implement a second urban Logan Express service at North Station.
- **TNC Management Plan**
  - Facilitate rematch and shared ride by moving TNC drop-off and pick-up activity to new dedicated areas in the Central Garage.
  - Implement TNC rematch[18] so drivers dropping off can more easily leave with a passenger.
  - Introduce TNC shared ride incentives to reduce TNC vehicles through gateways by increasing vehicle occupancies.
  - Adopt new TNC fee structure to support HOV strategies, encourage shared rides, and reduce gateway congestion.
  - Optimize TNC operations on-Airport through data reporting, enforcement tools, and emerging TNC products.
- **Infrastructure improvements**
  - Through ongoing studies of future growth scenarios, and the likely impacts on ground operations, Massport has identified the need for additional infrastructure modifications as a complement to policy changes to allow terminal area roadways and curbsides to continue functioning adequately and minimize vehicle idling and associated emissions.
  - A range of infrastructure alternatives will be considered for implementation in the next 10 to 15 years. Options to be considered may include on-Airport dedicated HOV bus lanes, the creation of an intermodal transportation center with bus service to terminals, the construction of an Automated People Mover (APM), or some combination of these and other improvements. These concepts will be described in future EDR/ESPR filings and may be advanced for MEPA and or National Environmental Policy Act (NEPA) reviews as those concepts evolve.

18 Rematch allows drivers who are dropping off to instantly pick up another passenger without needing to circle the Airport or leave empty.

Noise Strategy

Massport strives to minimize the noise effects of Logan Airport operations on its neighbors through a variety of noise abatement programs, procedures, studies, and other tools. At Logan Airport, Massport implements one of the longest standing and most extensive noise abatement programs of any airport in the nation. Massport's comprehensive noise abatement program includes a dedicated Noise Abatement Office; a state-of-the-art Noise and Operations Monitoring System (NOMS); extensive residential and school sound insulation programs; time-of-day and runway restrictions for noisier aircraft; ground run-up procedures; and flight tracks designed to optimize over-water operations (especially during nighttime hours). The public can register noise complaints by phone or online through Massport's website.[19]

The foundation of Massport's noise program is the *Logan Airport Noise Abatement Rules and Regulations*[20] (Noise Rules), which have been in effect since 1986. Massport's Noise Abatement Office is responsible for implementing noise abatement measures and generally monitoring community complaints and other aspects of the noise effects from Logan Airport operations.

Massport is focused on the following noise abatement initiatives:

- **Partnerships with Airlines and the FAA**
  - In October 2018, jetBlue Airways (the air carrier with the greatest number of operations at Logan Airport) announced plans to retrofit its older Airbus fleet with Vortex Generators, which reduce tonal noise on approach. This move reflects the partnership between Massport and the airlines to reduce aircraft noise to benefit surrounding communities. As airlines retrofit aircraft and transition to the newer models of the A320 family, the number of aircraft operating at Logan Airport without the vortex generators is expected to decrease. For more information, please refer to a press release discussing the generators in Chapter 6, *Noise Abatement*.

Image of Vortex Generator Device by Port on Wing.

  - On October 7, 2016, Massport and the FAA signed a Memorandum of Understanding (MOU)[21] to frame the process for analyzing opportunities to reduce noise through changes or amendments to performance-based navigation (PBN), including area navigation (RNAV). This cooperation is a first-in-the-nation project between the FAA and an airport operator to better understand the implications of PBN and evaluate strategies to address community concerns. The Massachusetts Institute of Technology (MIT) is the technical lead. Block 1 was completed

19 Massport. Noise Complaints. http://www.massport.com/logan-airport/about-logan/noise-abatement/complaints/.

20 The Logan International Airport Noise Abatement Rules and Regulations, effective July 1, 1986, are codified as 740 Code of Massachusetts Regulations (CMR) 24.00 et seq (also known as the Noise Rules).

21 Massport. October 7, 2016. *Massport and FAA Work to Reduce Overflight Noise.* https://www.massport.com/news-room/news/massport-and-faa-work-to-reduce-overflight-noise/.

  in late 2017 and recommendations were made to the FAA. Currently, MIT is conducting the analysis for Block 2.

  - The fleet operating at Logan Airport is comprised of 80 percent Stage 4 aircraft and 18 percent Stage 5 aircraft (Stage 5 being the quietest), well above the FAA minimum Stage 3 engines.
  - Massport continues to prohibit the use of Runways 4L for departures and Runway 22R for arrivals from 11:00 PM to 6:00 AM; maximize late-night over-water operations via Runways 15R and 33L; and restrict nighttime engine run-ups and use of APUs.
  - Massport continues to encourage the voluntary use of reduced-engine taxiing when appropriate and safe (see Appendix L, *Reduced/Single Engine Taxiing at Logan Airport Memoranda*).
  - Massport continues improvement of the Noise Monitoring System and is going out to bid for an upgraded system.

- **Sound Insulation Program**
  - Massport has one of the most extensive residential and school sound insulation programs in the nation. To date, Massport has installed sound insulation in 5,467 residences, including 11,515 dwelling units, and 36 schools in East Boston, Roxbury, Dorchester, Winthrop, Revere, Chelsea, and South Boston.
  - Approximately 8 percent of applicants also choose the Room-of-Preference option that allows the owner to identify a room (usually a bedroom or living room) for extra acoustical treatment.

Sustainability and Resiliency Program

Massport is committed to a robust sustainability program. Sustainability has redefined the values and criteria for measuring organizational success by using a "triple bottom line" approach that considers economic, ecological, and social well-being. Applying this approach to decision-making is a practical way to optimize economic, environmental, and social capital. Massport is taking a broad view of sustainability that builds upon the triple bottom line concept and considers the airport-specific context. Consistent with the Airports Council International - North America's (ACI-NA) definition of Airport Sustainability,[22] Massport is focused on a holistic approach to managing Logan Airport to ensure Economic viability, Operational efficiency, Natural resource conservation, and Social responsibility (EONS). Massport is committed to implementing environmentally sustainable practices Airport- and Authority-wide and continues to make progress on a range of initiatives. The following sections summarize many of the long-term and multifaceted sustainability initiatives undertaken by Massport, which individual chapters of this *2017 ESPR* more fully describe, where appropriate. **Figure 1-9** highlights some of Massport's recent sustainability initiatives.

22 Airports Council International (ACI). Airport Sustainability: A Holistic Approach to Effective Airport Management. Undated. http://www.aci-na.org/static/entransit/Sustainability%20White%20Paper.pdf.

Figure 1-9 Recent Sustainability Highlights

- Five LEED (Leadership in Energy and Environmental Design) Certified Facilities at Logan Airport
- Sustainability Management Plan and Annual Reporting
- Sustainable Design Standards and Guidelines
- Climate Change and Resiliency Planning – 60% of Critical Assets Enhanced
- Rooftop Solar at Economy Garage, Rental Car Center, Green Bus Depot, Terminal B Garage, Terminal A, and Logan Office Center
- Alternative Fuel Vehicle (AFV) Program – Converting Tenant and Massport Fleets to Compressed Natural Gas (CNG) or Electricity
- Conversion of Gas- and Diesel-Powered Ground Service Equipment (GSE) to Electric Versions
- Commitment to Community Park and Open Space – Over 33 Acres of Green Space in East Boston
- Stakeholder Engagement for "Sustainable Massport 2.0" Planning Effort

Logan Airport Sustainability Management Plan (SMP)

In 2013, Massport was awarded a grant by the FAA to prepare a SMP for Logan Airport. The Logan Airport SMP planning effort began in May 2013 and was completed in April 2015. The Logan Airport SMP takes a broad view of sustainability including economic vitality, operational efficiency, natural resource conservation, and social responsibility considerations. The Logan Airport SMP is intended to promote and integrate sustainability Airport-wide and to coordinate ongoing sustainability efforts across Massport. The Logan Airport SMP developed a framework and implementation plan, with metrics and targets, designed to track progress over time.

Massport is currently working on a vision for Massport's "Sustainability 2.0" as a next-level planning effort to implement principles and approaches from the SMP at other Massport facilities and to update Massport's sustainability goals and targets. Massport is currently advancing a series of short-term initiatives to help reach its goals (see **Table 1-2**) in the areas of (1) energy and GHG emissions; (2) water conservation; (3) community, employee, and passenger well-being; (4) materials, waste management, and recycling; (5) resiliency; (6) noise abatement; (7) air quality improvement; (8) ground access and connectivity; (9) water quality/stormwater; and (10) natural resources. Massport reports its progress towards achieving each goal, including changes in related performance, in sustainability reports. Since the publication of the Logan Airport SMP, Massport has continued expanding its sustainability initiatives, with an increased focus on implementing resliency measures to protect Maritime and Logan Airport operations, cirital infrastructure, and workforce.

The Logan Airport Annual Sustainability Report, first published in April 2016, provides a progress summary of sustainability efforts at Logan Airport based on Massport's sustainability goals and targets established in the Logan Airport SMP. It highlights Massport's progress towards improving sustainability and enhancing resiliency at its facilities. This report, now called the Annual Sustainability & Resiliency Report, was updated in April 2018 to include resiliency initiatives and can also be found at: http://www.massport.com/massport/business/capital-improvements/sustainability/sustainability-management/.

Table 1-2 Logan Airport Sustainability Goals and Descriptions

Sustainability Category	**Goal**	**Sustainability Category**	**Goal**
Energy and Greenhouse Gas (GHG) Emissions	Reduce energy intensity and GHG emissions while increasing the portion of Massport's energy generated from renewable sources.	Water Conservation	Conserve regional water resources through reduced potable water consumption.
Community, Employee, and Passenger Well-being	Promote economically prosperous, equitable, and healthy communities and passenger and employee well-being.	Materials, Waste Management, and Recycling	Reduce waste generation, increase the recycling rate, and utilize environmentally sound materials.
Resiliency	Become an innovative and national model for resiliency planning and implementation among port authorities.	Noise Abatement	Minimize noise impacts from Massport's operations.
Air Quality Improvement	Decrease emissions of air quality criteria pollutants from Massport sources.	Ground Access and Connectivity	Provide superior ground access to Logan Airport through alternative and high-occupancy vehicle (HOV) travel modes.
Water Quality/Stormwater	Protect water quality and minimize pollutant discharges.	Natural Resources	Protect and restore natural resources near Massport facilities.

Leadership in Energy and Environmental Design (LEED®)-Certified Facilities at Logan Airport

The United States Green Building Council's (USGBC's) LEED rating system is the most widely recognized third-party green building certification system in North America. Massport is striving to achieve LEED certification for all new and substantial renovation building projects over 20,000 square feet. Most recently, in 2017, the Terminal E New Large Aircraft Wing (Terminal E Renovation and Enhancements Project) received LEED Gold certification for Commercial Interiors. Other recent examples of LEED-certified buildings at Logan Airport are the RCC and Green Bus Depot (see **Figure 1-10** and **Table 1-3**). Further details are available in Chapter 3, *Airport Planning*.

Figure 1-10 LEED-Certified Facilities at Logan Airport

Signature Flight Support General Aviation Facility, LEED Certified (2008)

Terminal A, LEED Certified (2006)

Rental Car Center, LEED Gold Certified (2015)

Green Bus Depot, LEED Silver Certified (2014)

Terminal E New Large Aircraft Wing, LEED Gold Certified (2017)

Sustainability Design Standards and Guidelines and LEED Certification

For smaller building projects and non-building projects, Massport uses its *Sustainable Design Standards and Guidelines* (SDSGs). The SDSGs provide a framework for sustainable design and construction for both new construction and rehabilitation projects. The SDSGs apply to a wide range of project-specific criteria, such as site design, project materials, energy management and efficiency, air emissions, water management quality and efficiency, indoor air quality, and occupant comfort. Massport is also considering the use of the USGBC's sustainability-focused Parksmart rating system, an environmental and sustainability focused rating system specific to parking structure management, programming, design, and technology.

Table 1-3 Leadership in Energy and Environmental Design (LEED)-Certified Facilities at Logan Airport

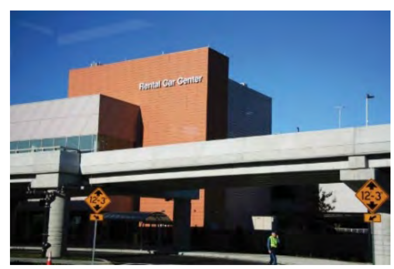
Terminal A (LEED Certified) Completed 2005/2006

- First airport terminal in the world to be LEED Certified
- Priority curb locations for high-occupancy vehicles (HOV) and bicycles
- Retrofitting with solar panels on the Terminal A roof
- Stormwater filtration
- Reflective roof
- Water use reduction features
- Natural daylighting paired with advanced lighting technologies for energy efficiency
- Use of recycled and regionally sourced materials
- Measures to enhance indoor air quality

Signature Flight Support General Aviation Facility (LEED Certified) Completed 2007/2008

- Mechanisms to reduce water use
- Natural day lighting with advanced lighting technologies for energy efficiency
- Window glazing and sunshades to maximize daylight and minimize heat build-up
- Recycled and regionally sourced materials
- Measures to enhance indoor air quality

Rental Car Center (RCC) (LEED Gold) Completed 2013



- Green building materials
- Rooftop solar panels
- Bike and pedestrian access and connections
- Natural day lighting and advanced lighting technologies for energy efficiency
- Use of recycled and regionally sourced materials
- Enhanced indoor air quality
- Plug-in stations for electric vehicles and other alternative fuel sources such as E-85 (ethanol)
- Rental car fleets which include hybrid/alternative fuel/low emitting vehicles
- Pedestrian connections
- Bicycle facilities and employee showers/changing
- Water reclamation for vehicle wash water, and use of stormwater for non-potable uses such as vehicle washing and landscaping irrigation
- Vehicle miles traveled (VMT) reduction

Green Bus Depot (LEED Silver) Completed 2014

- Rooftop solar panels
- Water and energy saving features
- VMT reduction
- New shuttle fleet including 50 clean diesel/electric hybrid buses and compressed natural gas (CNG) buses
- Sustainably grown, harvested, produced, and transported building materials

Table 1-3 Leadership in Energy and Environmental Design (LEED)-Certified Facilities at Logan Airport (Continued)

Terminal E New Large Aircraft Wing (LEED Gold - Commercial Interiors) Completed 2017

- Reduces heat island effect by providing a reflective white roof and a light color concrete tarmac
- Low-flow water fixtures and water closets
- Efficient light fixtures and efficient heating, ventilation, and air conditioning (HVAC) system
- Use of renewable energy sources
- Recycled and regionally sourced materials
- Enhanced indoor air quality
- Solar-thermal domestic hot water system to heat 100 percent of the wing's domestic water needs

Climate Change and Resiliency Planning

As the Boston area will continue to experience increased temperatures, more frequent extreme weather events, and higher sea level due to climate change,[23] Massport understands the importance of preparing for impacts to protect and enhance its critical infrastructure, operational assets, and workforce. Through robust planning and regional collaboration, Massport strives to continue its leadership role in resiliency planning among port authorities, the airport industry, and the Boston region.

At the end of 2013, Massport initiated a Disaster and Infrastructure Resiliency Planning (DIRP) Study for Logan Airport, the Port of Boston, and Massport's waterfront assets in South and East Boston. The DIRP Study includes a hazard analysis, modeling sea-level rise and storm surge, and projections of temperature, precipitation, and anticipated increases in extreme weather events. The DIRP Study provides recommendations regarding short-term strategies to make Massport's facilities more resilient to the likely effects of climate change. In 2014, the study was completed, and implementation of adaptation initiatives began, in late 2014.

In addition to the DIRP Study and its related initiatives, Massport has completed an Authority-wide risk assessment, as part of its strategic planning initiative; issued a Floodproofing Design Guide; and has developed a resilience framework to provide consistent metrics for short- and long-term planning and protection of its critical facilities and infrastructure. Beyond physical resiliency, Massport is also focused on incorporating social and economic resilience into its long-term operational and capital planning. Massport's Floodproofing Design Guide was published in November 2014 and updated in April 2016.

Operational aspects of resiliency strategy include the development of Flood Operations Plans for Logan Airport and Massport maritime facilities. These plans were introduced in 2015 and included the planned deployment of temporary flood barriers to protect up to 12 locations of critical infrastructure in the event of severe weather. Additional locations have been permanently enhanced to prevent flooding.

23 City of Boston. 2016. *Climate Ready Boston*. https://www.boston.gov/sites/default/files/climatereadyeastbostoncharlestown_finalreport_web.pdf.

The flood operations plans are evaluated annually to enhance their effectiveness and to adapt to evolving requirements and past experiences.

Tabletop planning exercises simulating a hurricane scenario and cross-functional workshops have been conducted to further refine plans and train staff. Finally, the design flood elevation that resulted from the original DIRP study in 2015 was updated as a result of enhanced storm modeling that was made available to Massport through MassDOT. Adjustments to the prioritized resiliency recommendations were made to accommodate the revised flood elevation.

Massport reports on progress towards resiliency goals in its Logan Airport Annual Sustainability Reports. Additional information about Massport's resiliency initiative is available at: http://www.massport.com/massport/business/capital-improvements/sustainability/climate-change-adaptation-and-resiliency/resiliency-and-climate-change/.

Massport Partnerships and Community Support

Massport has a long-standing commitment to be a good neighbor. Working in concert with government, community, and civic leaders throughout Massachusetts and New England, Massport is an active participant in efforts that improve the quality of life for residents living near Massport's facilities. Massport employees participate in a number of community activities. In the spring, Massport employees participate in the City of Boston's annual neighborhood Boston Shines clean-up. At Thanksgiving, Massport employees provide food donations to three community programs, which serve more than 500 families and individuals each month. In the fall, children ages four to 17 are provided with a new backpack filled with school supplies and new clothes at the start of the school year. Over the holidays, Massport invites students from neighboring communities and elementary schools to sing at Terminal A as part of its annual holiday music program.

In 2016, Massport provided financial support to over 60 community organizations including: Boys & Girls Clubs, the Codman Square and South Boston Health Centers, and several youth and recreational organizations. In April 2017, Massport hosted the annual Aviation and Maritime Science, Technology, Engineering, and Mathematics (STEM) Education Expo at Logan Airport for more than 1,700 students from most of the 40 Greater Boston schools. Massport also offers several scholarship opportunities for graduating high school seniors. Additionally, Massport and jetBlue host the American Cancer Society's inaugural "Pulling for Hope" where people pull a 100,000-pound jet at Logan Airport to raise money for cancer research.

For a full list of Massport's partnership efforts go to: http://www.massport.com/massport/community/community-partners/.

East Boston Foundation. Created by Massport in 1997 at the request of the community, the East Boston Foundation has provided nearly $10 million in financial support for 85 community programs that benefit children, adults, and seniors, from sports and recreation to education, training, and child care. The East Boston Foundation Board of Trustees are committed to financial stewardship, recognizing the evolving needs of the community, and enhancing the quality of life for all East Boston residents.

Massport Means Business. Massport is taking steps to create more business opportunities at Logan Airport for East Boston companies. In 2016, Massport, the East Boston Chamber of Commerce, and East Boston Main Streets co-hosted the *MASSPORT MEANS BUSINESS* initiative to learn more about doing business with Massport. Massport's mission is to ensure that East Boston businesses have every opportunity to thrive by partnering with us to serve our passengers, airlines, security, and maintenance needs.

Open Space/Buffer Program. Massport has invested in an extensive open space program to enhance the surrounding communities. Massport initially committed over $15 million for the planning, construction, and maintenance of four Airport edge buffer areas and two parks along Logan Airport's perimeter. These buffers include the Bayswater Buffer, Navy Fuel Pier Buffer, and the SWSA Buffer (Phases I and II). The award-winning Piers Park was completed in 1995 and has since become part of a network of greenspace that traverses East Boston from the Jeffries Point waterfront to Constitution Beach.

Adjacent to the current Piers Park, Piers Park Phase II will add approximately 4.2 acres of green space to the East Boston waterfront upon completion, and plans are underway by an outside party for Piers Park Phase III, which will turn an aging pier into a 3.6-acre greenspace that will include resiliency features to help protect the neighborhood from flooding and sea level rise. Today, East Boston enjoys 3.3 miles and more than 33 acres of green space developed or managed by Massport, in partnership with and in response to engagement with the East Boston community. More information can be found in Chapter 3, *Airport Planning*.

Figure 1-11 Parks Owned and Operated by Massport and City of Boston

Source: VHB.

2017 and Future Planning Horizon Highlights and Key Findings

This section provides a brief overview of key findings, by chapter, at Logan Airport in 2017 and the Future Planning Horizon. Additional information concerning Airport activities is provided in subsequent chapters. This section will also highlight Massport's efforts to further sustainability through specific projects and initiatives with a sustainability leaf and summarizes Massport's sustainability program.

Activity Levels

Logan Airport (and the aviation industry in general) has been experiencing strong growth, largely driven by the positive economic conditions in the Boston region, low unemployment, a strong, diverse economic base, and continued investment in commercial and residential real estate, particularly in life sciences, finance, healthcare, and higher education. The expansion of international routes served from Logan Airport supports the economic opportunities Massachusetts residents have by enabling them to reach dozens of markets throughout the world and improving competitiveness as a top-tier global location for business, research, education, technology, and tourism.[24]

In 2017, air passenger activity levels at Logan Airport reached an all-time high of 38.4 million, an increase of 5.9 percent over 2016. Aircraft operations increased at a slower rate, totaling 401,371 in 2017, an increase of 2.6 percent over 2016 levels. This trend continued in 2018 with air passenger activity levels of 40.9 million and aircraft operations totaling 424,024. The growth is directly correlated to the strong national and regional economy. Aircraft operations remain well below the 487,996 operations in 2000 and the historic peak of 507,449 operations reached in 1998.

From 2010 to 2017, the annual number of passengers at Logan Airport increased by about 40 percent, while the annual number of aircraft operations[25] increased at a slower rate, about 14 percent, due to increasing aircraft load factors. International passenger levels increased at a faster rate than domestic passenger levels in 2017. Domestic air passenger activity levels increased by 5.1 percent while international air passenger activity levels increased by 9.3 percent over 2016 levels.

As part of its ongoing strategic planning effort, Massport prepares aircraft operations and passenger activity level forecasts every few years. This *2017 ESPR* evaluates future operational and environmental conditions associated with a projected 50 million annual air passengers in the next 10 to 15 years (the Future Planning Horizon). This level of air passengers is forecast to be accommodated in approximately 486,000 annual aircraft operations. Massport's forecast is consistent with the FAA's Terminal Area Forecast; within the 10- to 15-year planning horizon, the FAA forecasts 50 million annual air passengers.

Please see Chapter 2, *Activity Levels,* for additional information.

24 *Mass*Benchmarks. 2018. *The Journal of the Massachusetts Economy, Volume 20 Issue 2.*

25 An aircraft operation is defined as one arrival or one departure.

Airport Planning

Massport is continually improving the facilities at Logan Airport to accommodate changes in passenger demand, aircraft activity, cargo needs, and transportation access. In Chapter 3, *Airport Planning*, Massport has identified priority planning projects and initiatives to accommodate the increased demand in international and domestic travel including projects and initiatives in the following categories:

- Ground Transportation and Parking;
- Terminals;
- Airside Planning;
- Service Areas;
- Airport Buffers and Open Space; and
- Energy, Sustainability, and Resiliency.

Massport is currently focused on enhancing the passenger and user experience at Logan Airport both on-Airport and by improving accessibility to and from this regional asset. Recent and ongoing terminal area projects are providing seamless post-security connectivity among the terminals along with enhancements to passenger processing through consolidated security checking areas.

To relieve on-Airport roadway congestion and accessibility, Massport plans to implement major on-Airport roadway and MBTA Blue Line/intra-terminal connectivity projects and construct consolidated TNC drop-off and pick-up areas. Massport also has plans to expand HOV services and Logan Express facilities as part of a program of ground transportation-related improvements.

Since the *2016 EDR* was filed, Massport has submitted two projects for MEPA review:

- The Terminal E Modernization Project, which has been approved to add seven new gates to the international terminal.
- The Logan Airport Parking Project, which will add 5,000 commercial parking spaces at Logan Airport in locations already in use for parking. The additional parking spaces can be permitted based on a modification to the Logan Airport Parking Freeze[26] and are intended to reduce environmentally harmful drop-off/pick-up modes (i.e., dropped off or picked up by private vehicles, taxi, TNC, or black car limousine service. This project is currently undergoing joint MEPA/NEPA review.

Massport continues to work with the FAA to enhance airside safety through a variety of RSA projects and simplification of the airfield geometry. Please see Chapter 3, *Airport Planning,* for additional information.

26 310 Code of Massachusetts Regulations 7.30 and 40 Code of Federal Regulations 52.1120.

Regional Transportation

In 2017, the New England region saw an increase in air passenger activity. Regional air passengers increased by 5.5 percent to 54.7 million air passengers in 2017, a historic high. The 10 regional airports (excluding Logan Airport) in New England accommodated 16.3 million air passengers in 2017, compared to 15.6 million passengers in 2016.

Worcester Regional Airport, Bradley International Airport, T.F. Green Airport, Portland International Jetport, and Burlington International Airport saw an overall increase in service offerings in 2017. Manchester-Boston Regional and Tweed-New Haven airports saw reduced service offerings in 2017. Massport's three airports, Logan Airport, Worcester Regional Airport, and Hanscom Field, make significant contributions to the regional economy, generating approximately $23.1 billion annually, or 94 percent of the overall economic benefits generated by the Massachusetts airport system. Hanscom Field is a reliever airport to Logan Airport and is the second busiest airport in New England.

jetBlue E-190 aircraft at Worcester Regional Airport. Source: Massport.

Worcester Regional Airport saw passenger numbers increase 32 percent in 2018 compared to 2017 and reported a total of approximately 600,000 passengers from 2013 to 2018. In the past five years, Worcester Regional Airport has experienced an average growth rate of 30 percent per year. Massport continues to invest in Worcester Regional Airport—together with the City of Worcester, Massport has already initiated a $100 million, 10-year investment to revitalize and attract commercial operations to Worcester Regional Airport. Investments include a CAT III Instrument Landing System (about $32 million) paid for by federal grants and Massport funds. Additionally, jetBlue Airways, American Airlines, and Delta Air Lines announced new service to JFK, Philadelphia International Airport, and Detroit Metropolitan Wayne County Airport, respectively.

Amtrak rail system-wide ridership remained flat at 31.7 million customer trips from fiscal year (FY) 2017 to FY 2018. The Northeast Corridor (NEC) carried over 12 million passengers, up about 1 percent from the prior year. In mid-2018, Amtrak announced $370 million in investments in new equipment to install double track infrastructure maintenance capacity on the NEC over the next three years, along with next-generation Acela Express trainsets that will increase per train seat capacity by 27 percent.[27]

27 Amtrak. 2018. *FY 18 Company Profile*. http://media.amtrak.com/wp-content/uploads/2019/03/Amtrak-Corporate-Profile_FY2018_Pub-March-1-2019.pdf.

Ground Access to and from Logan Airport

Massport has a comprehensive, multi-pronged, trip reduction strategy to diversify and enhance ground transportation options for passengers and employees traveling to and from Logan Airport. The ground transportation strategy is designed to offer passengers traveling to and from Logan Airport a choice of HOV, transit, and shared-ride options that are convenient and reliable, and that reduce environmental and community impacts. Logan Airport continues to be one of the top of U.S. airports in terms of HOV and transit mode share. Massport promotes numerous HOV, transit, and shared-ride options to improve on Airport roadway and curbside operations, alleviate constraints on parking, and improve customer service. Key initiatives include:

- A goal to double Logan Express ridership by expanding parking, frequency, and facility upgrades;
- A plan to purchase eight additional MBTA Silver Line buses, increasing the fleet size purchased by Massport to 16 buses; and
- Implementation of a TNC (such as Uber and Lyft) management plan to reduce congestion on-Airport, including a focus on ride rematch and shared-ride.

Framingham Logan Express bus
Source: Alan Dines

Massport's strategy also aims to provide sufficient on-Airport parking for air passengers choosing automobile access modes and/or who have limited HOV options. In 2017, the Massachusetts Department of Environmental Protection (MassDEP) amended the Logan Airport Parking Freeze to allow for an increase of up to 5,000 on-Airport commercial parking spaces, which allows for the construction of additional parking to reduce drop-off/pick up modes and alleviate constrained on-Airport parking conditions.

Key findings are summarized in the bullets that follow and additional details can be found in Chapter 5, *Ground Access to and from Logan Airport*.

- Average weekday on-Airport VMT increased by about 11 percent from approximately 176,840 in 2016 to 196,500 in 2017. The change in average daily traffic can be attributed primarily to the increases in air passenger activity, passenger drop-off/pick-up, cargo, and non-aviation related Airport uses.
- In 2017, Massport began tracking and reporting TNC activity. TNCs were estimated to contribute about 15,000 vehicle trips per day (excluding deadhead trips[28]). TNCs are impacting other access modes to the Airport and contributing to on-Airport congestion. Partially due to the emergence of TNCs, black car limousines and scheduled van ridership dropped by 40 percent from 2016 to 2017. Taxi dispatches declined 18 percent and MBTA Blue Line ridership decreased by 2 percent in 2017 compared to 2016.

28 Deadhead trips are those trips to or from the Airport that do not contain a passenger.

- Based on ongoing changes in passenger mode choice for accessing Logan Airport, Massport has updated its goals and definition of HOV. The updated definition considers vehicle occupancies of taxis, black car limousines, and TNCs that exceed one air passenger per vehicle to be HOV, while the same modes with one air passenger will count as non-HOV. With this updated definition, Massport has committed to a goal of 35.5 percent HOV by 2022 and 40 percent by 2027.
- When activity levels reach 50 million air passengers, it is anticipated that Massport transportation policy changes and potential infrastructure modifications that reduce on-Airport VMT will be in place. Infrastructure modifications may include on-Airport dedicated HOV bus lanes, the creation of an intermodal transportation center with bus service to terminals, the possible construction of an APM, or some combination of these improvements.

Noise Abatement

Massport strives to minimize the noise effects of Logan Airport operations on its neighbors through a variety of noise abatement programs, procedures, studies, and other tools. At Logan Airport, Massport implements one of the oldest and most extensive noise abatement programs of any airport in the nation. Massport's comprehensive noise abatement program includes a dedicated Noise Abatement Office; a state-of-the-art NOMS; extensive residential and school sound insulation programs; time-of-day and runway restrictions for noisier aircraft; ground run-up procedures; and flight tracks designed to optimize over-water operations (especially during nighttime hours). The public can register noise complaints by phone or online through Massport's website.[29]

Key findings are summarized in the bullets that follow and additional details can be found in Chapter 6, *Noise Abatement*.

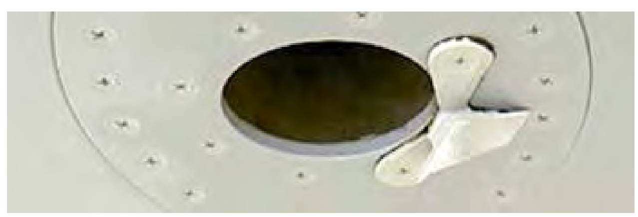


Image of Vortex Generator Device by Port on Wing.

- Massport is encouraging retrofitting the Airbus A319/320/321 family with vortex generators, which reduce tonal noise on approach. United Airlines announced it was retrofitting its aircraft in 2017 as they went in for service. In a press release in October 2018, jetBlue Airways (the largest air carrier operator at Logan Airport) announced plans to retrofit its older Airbus fleet with vortex generators.
- The fleet mix of aircraft at Logan Airport continues to be composed of aircraft types with the quietest available technology, with Stage 5 being the quietest. Approximately 18 percent of 2017 operations were conducted in aircraft meeting Stage 5 requirements, 80 percent meeting Stage 4 requirements, and 2 percent in Certified Stage 3. In the Future Planning Horizon, the fleet will be approximately 56 percent Stage 5, 43 percent Stage 4, and 2 percent Stage 3 aircraft. The expected modernization of the fleet mix and forecast day/night split is expected to moderate the effect of the forecast increase in aircraft operations.

29 Massport. Noise Complaints. http://www.massport.com/logan-airport/about-logan/noise-abatement/complaints/.

- Massport and the FAA are working with the MIT to investigate opportunities to reduce noise through changes to PBN, including RNAV. This cooperation is a first-in-the-nation project between the FAA and an airport operator to better understand the implications of PBN and evaluate strategies to address community concerns.
- Massport continues to be a national leader in sound insulation mitigation. To date, Massport has provided sound insulation for a total of 36 schools and 11,515 residential units and will continue to seek funding for mitigation for properties that are eligible and whose owners have chosen to participate.
- Nighttime operations represent 15 percent of total operations for 2017 at Logan Airport. Nighttime operations increased, from an average of 152 per night in 2016 to 168 in 2017. The majority (82 percent) of nighttime operations occurred either before midnight or after 5:00 AM.
- The 2017 Day-Night Average Sound Level (DNL) contour is similar in shape and size to that for 2016, with slight increases overall. The total number of people residing within the DNL 65 decibel (dB) contour increased from 7,450 in 2016 to 7,933 in 2017, an increase of 483 people. The additional population within the DNL 65 dB contour is mainly located in Chelsea and in the area of East Boston between the Runway 15R and Runway 22R ends. This increase is primarily due to the increase in Runway 33L departures. Changes in runway use, primarily due to the Runway 4R closure, and an increase in nighttime operations were also contributors to changes in the number of people exposed to DNL values greater than or equal to 65 dB in 2017.
- In the Future Planning Horizon, the DNL 65 dB contour expands in certain areas due to the expected growth in number of operations. The total number of people residing within the DNL 65 dB contour is expected to increase from 7,933 in 2017 to 8,356 in the future, an increase of 423 people, all within areas already sound-insulated by Massport or eligible for sound insulation in the past.
- Compared to 1990, the total number of people residing in the DNL 65 dB contour is about 82 percent lower and 81 percent lower in 2017 and the Future Planning Horizon, respectively, due to improved engine technology.

Air Quality/Emissions Reduction

Massport's air quality management strategy for Logan Airport focuses on decreasing emissions from Airport-related sources. Since Massport does not have direct control over aircraft operations or fleet choices by the airlines, it continues to focus on areas that Massport does control or has an opportunity to influence. Key Massport initiatives to reduce air emissions from Airport operations include:

- Replacement of gas- and diesel-powered GSE with electric equivalents by the end of 2027, where commercially available;
- Commitment to LEED® and other sustainable building standards;
- Investment in renewable energy installations on-Airport (solar/wind);
- Use of clean-fuel shuttle buses; and
- Implementation of extensive strategies to promote HOV use and ground transportation improvements.

Massport prepared emissions inventories for 2017 for the criteria pollutants carbon monoxide (CO), particulate matter (PM_{10}/$PM_{2.5}$), and volatile organic compounds (VOCs), as well GHGs and oxides of nitrogen (NO_x). Massport also prepared emissions inventories for the Future Planning Horizon. Key findings of those emissions inventories include:

- Total modeled emissions of CO, PM_{10}/$PM_{2.5}$, and VOCs have decreased from 2016 to 2017 by about 4 percent, 20 percent, and less than 1 percent, respectively, even though aircraft operations have increased over the same time period. In the future, total emissions of CO, PM_{10}/$PM_{2.5}$, and VOCs are predicted to decrease further by about 2 percent, 10 percent, and 8 percent, respectively, compared to 2017 levels. The projected reduction in emissions is due to a combination of the conversion of GSE to viable electric alternatives, lower motor vehicle emissions due to greater efficiency, cleaner aircraft engine technologies, and changes in aircraft fleet mix.
- Total emissions of NO_x increased by about 12 percent from 2016 to 2017. This increase in NO_x is almost entirely attributed to the changing aircraft fleet (i.e., greater use of quieter, more fuel-efficient aircraft engines that overall result in fewer emissions with the exception of NO_x) coupled with the forecasted increase in aircraft operations at the Airport. Emissions of NO_x are predicted to increase by about 37 percent in the Future Planning Horizon compared to 2017. The changes are also attributable to the FAA's Aviation Environmental Design Tool (AEDT) model, which assumes higher NO_x emission factors compared to the legacy Emissions and Dispersion Modeling System (EDMS) model. NO_x emissions associated with GSE, motor vehicles, and stationary sources, many of which Massport has control or influence, have declined.
- GHG emissions increased from 2016 to 2017 by about 8 percent due primarily to the increase in aircraft operations. Total Logan Airport GHG emissions, however, remained less than 1 percent of statewide emissions in 2017. Total emissions of GHG in the Future Planning Horizon are predicted to be about 23 percent higher than 2017 levels predominantly due to the predicted increase in aircraft operations.

Please see Chapter 7, *Air Quality/Emissions Reduction,* for additional information.

Water Quality/Environmental Compliance and Management

Massport's approach to environmental management and compliance is a key component of its commitment to sustainability and responsible stewardship at Logan Airport. Through monitoring and documentation, Massport assesses environmental performance, continually developing, implementing, evaluating, and improving policies and programs. Massport promotes appropriate environmental practices through pollution prevention and remediation measures. Massport also works closely with tenants and operations staff at Logan Airport in an effort to continuously improve environmental compliance. Key findings in this ESPR include:

- In 2017, 100 percent of Massport's stormwater samples were in compliance with National Pollutant Discharge Elimination System (NPDES) permit requirements.
- Massport has had its International Organization for Standardization (ISO) 14001 Environmental Management System (EMS) in place since 2006.

- Massport periodically updates and maintains its Stormwater Pollution Prevention Plan (SWPPP) for Logan Airport.
- Massport continues to assess, remediate, and bring to regulatory closure areas of subsurface contamination.
- Eight spills required reporting in 2017, a decrease from the 2016 reportable spills (14 total). The number of spills entering a drainage system also decreased, from five in 2016 to two in 2017.

For additional information, please see Chapter 8, *Environmental Compliance and Management/Water Quality*.

Logan Airport Environmental Review Process

This *2017 ESPR* is part of a well-established, formal state-level environmental review process that assesses Logan Airport's cumulative environmental impacts. The process provides a context against which individual projects at Logan Airport meeting state and federal environmental review thresholds are evaluated on a project-specific basis. The Airport-wide and project-specific environmental review processes are described below.

Historical Context for the Logan Airport EDR/ESPR

In 1979, the Secretary of EEA issued a Certificate requiring Massport to define, evaluate, and disclose every three years the impact of long-term growth at the Airport through a Generic Environmental Impact Report (GEIR). The Certificate also required interim Annual Updates to provide data on conditions for the years between GEIRs. The GEIR evolved into an effective planning tool for Massport and provided projections of environmental conditions so that the cumulative effects of individual projects could be evaluated within a broader context.

EEA eliminated GEIRs following the 1998 revisions to its MEPA regulations. However, the Secretary's Certificate on the 1997 Annual Update[30] proposed a revised environmental review process for Logan Airport resulting in Massport's preparation of subsequent EDRs/ESPRs. The more comprehensive ESPRs provide a long-range analysis of projected operations, passengers, and cumulative impacts, while EDRs are prepared annually to provide a review of environmental conditions for the reporting year compared to the previous year. The EDR/ESPR process was developed to allow individual projects at Logan Airport to be considered and analyzed in the broader, Airport-wide context. As stated in the introduction to the *1999 ESPR*, "while the Logan ESPR and EDRs provide the broad planning context for projects proposed for Logan Airport and future planning concepts under consideration by Massport, no specific projects can be built solely on the basis of inclusion and discussion in the *1999 ESPR*." It continues to state that projects that meet MEPA or NEPA review thresholds must undergo those processes, as needed. In short, the EDRs/ESPRs provide a cumulative planning context which complements the individual project-specific filings.

30 Certificate of the Secretary of the Executive Office of Environmental Affairs on the Logan Airport 1997 Annual Update, issued on October 16, 1998.

In the last several years, aircraft operations and passenger activity levels and associated environmental effects have remained well below levels previously analyzed for Logan Airport. Thus, the forecasted aviation growth presented in the *2004 ESPR*, the predicate upon which the ESPR schedule was initially established, has not occurred. Accordingly, with the approval of the Secretary, Massport prepared *2009* and *2010 EDRs* in lieu of the ESPR originally planned for 2009. The *2011 ESPR*, filed in early 2013, reported on calendar year 2011 and updated passenger activity level and aircraft operations forecasts. The combined *2012/2013 EDR* presented conditions for both calendar years 2012 and 2013. The *2014 EDR*, *2015 EDR*, and *2016 EDR* presented conditions for calendar years 2014, 2015, and 2016.

This *2017 ESPR* provides a comprehensive, cumulative analysis of activity levels and environmental conditions for that 2017 and the Future Planning Horizon. Massport proposes to prepare a combined *2018/2019 EDR* to report the effects of all Logan Airport activities based on actual passenger activity and aircraft operations in 2018 and 2019, with an anticipated publication by 2020. Where appropriate, Massport will continue to identify and address any longer-term aviation and environmental trends in both EDRs and ESPRs. As directed in the Secretary’s Certificate on the Terminal E Modernization Project ENF, the EDR/ESPR will continue to be the forum to address cumulative, Airport-wide impacts.

Project-Specific Review

While this Airport-wide review provides the broad planning context for proposed projects and future planning concepts, certain Airport projects are also subject to a project-specific, public environmental review process when they meet state environmental review thresholds. When required, Massport and Airport tenants submit ENFs and EIRs pursuant to MEPA. Similarly, where NEPA[31] environmental review is triggered, projects are reviewed under the NEPA environmental review process.

31 42 USC Section 4321 et seq. The Federal Aviation Administration (FAA) implements NEPA through FAA Order 1050.1E, Environmental Impacts: Policies and Procedures, Federal Aviation Administration, United States Department of Transportation, Effective Date: March 20, 2006.

Organization of the *2017 ESPR*

The remainder of this *2017 ESPR* includes:

- **Spanish Executive Summary** provides a translated version of the Executive Summary included after the English-version of Chapter 1, *Introduction/Executive Summary*.
- **Chapter 2, *Activity Levels***, presents aviation activity statistics for Logan Airport in 2017 and the Future Planning Horizon with a comparison to previous years. The specific activity measures discussed include air passengers, aircraft operations, fleet mix, and cargo/mail volumes.
- **Chapter 3, *Airport Planning***, provides an overview of planning, construction, and permitting activities that occurred at Logan Airport in 2017. It also describes known future planning, construction, and permitting activities and initiatives.
- **Chapter 4, *Regional Transportation***, describes activity levels at New England's regional airports in 2017 and updates recent regional planning activities.
- **Chapter 5*, Ground Access to and from Logan Airport***, reports on transit ridership, roadways, traffic volumes, and parking for 2017 and the Future Planning Horizon with a comparison to previous years.
- **Chapter 6, *Noise Abatement***, updates the status of the noise environment at Logan Airport in 2017 and the Future Planning Horizon with a comparison to previous years, and describes Massport's efforts to reduce noise levels.
- **Chapter 7, *Air Quality/Emissions Reduction***, provides an overview of Airport-related air quality in 2017 and the Future Planning Horizon with a comparison to previous years, and efforts to reduce emissions.
- **Chapter 8, *Environmental Compliance and Management/Water Quality***, describes Massport's ongoing environmental management activities including NPDES compliance, stormwater, fuel spills, activities under the Massachusetts Contingency Plan (MCP), and tank management.
- **Chapter 9, *Environmentally Beneficial Measures and Project Mitigation Tracking***, provides an overview of Massport's programs and initiatives that provide environmental benefits and reports on Massport's progress in meeting its MEPA Section 61[32] mitigation commitments for specific Airport projects.

32 Massachusetts General Law, Chapter 30, Section 61 (M.G.L. c. 30, § 61) states that all agencies must review, evaluate, and determine environmental impacts of all projects or activities and shall use all practicable means and measures to minimize damage to the environment. For projects requiring an Environmental Impact Report, Section 61 Findings will specify all feasible measures to be taken to avoid or mitigate environmental impacts, the party responsible for funding the mitigation measures, and the anticipated implementation schedule for mitigation measures.

MEPA Appendices: These include the Secretary of EEA's Certificate on the *2016 EDR*, the Secretary's Certificate on the *2016 EDR Notice of Project Change*, comment letters received on the *2016 EDR* and responses to those comments, Secretary Certificates on the EDRs/ESPRs issued for reporting years 2011 through 2015, a list of reviewers to whom this *2017 ESPR* was distributed, and a proposed scope for the *2018/2019 EDR*. Also included in this section are the Secretary's Certificates on the Terminal E Modernization Project ENF, Draft EA/EIR, Final EA/EIR, and the Secretary's Certificate on the Logan Airport Parking Project ENF.

Appendix A – MEPA Certificates and Responses to Comments[33]
Appendix B – Comment Letters and Responses
Appendix C – Proposed Scope for the 2018/2019 EDR[34]
Appendix D – Distribution List

Technical Appendices:[35] These include detailed analytical data and methodological documentation for the various environmental analyses presented in and conducted for this *2017 ESPR*.

Appendix E – Activity Levels
Appendix F – Regional Transportation
Appendix G – Ground Access
Appendix H – Noise Abatement
Appendix I – Air Quality/Emissions Reduction
Appendix J –Environmental Compliance and Management/Water Quality
Appendix K – Peak Period Pricing Monitoring Reports
Appendix L – Reduced/Single Engine Taxiing at Logan Airport Memoranda

33 The Secretary's Certificates on the Terminal E Modernization Project Environmental Notification Form, Draft EA/EIR and Final EA/EIR are included in Appendix A. For convenience, Massport has responded to comments that relate to the EDR and ESPR.

34 Massport proposes combining 2018 and 2019 reporting years in the next EDR, similar to what was published in the *2012/2013 EDR*. This report would be published in late 2020 and would provide modeled environmental conditions for calendar year 2018 and 2019.

35 Technical appendices are available on Massport's website at www.massport.com.

This Page Intentionally Left Blank.

Introducción/Resumen Ejecutivo

(Spanish Executive Summary)

This Page Intentionally Left Blank.

1

Introducción/Resumen ejecutivo

Introducción

Massachusetts Port Authority (Massport) continúa con su práctica de más de tres décadas de brindar un registro exhaustivo sobre las tendencias medioambientales, el planeamiento de las instalaciones, y los niveles de operaciones y de pasajeros y los compromisos de mitigación de Massport en este *Informe de estado medioambiental y planificación (Environmental Status and Planning Report, ESPR) de 2017 del Aeropuerto Internacional de Boston, Logan*.

El aeropuerto Logan, cuyo propietario y operador es Massport, cumple una función clave en las redes de transporte de pasajeros y de carga en el área metropolitana de Boston y de Nueva Inglaterra. Es el principal aeropuerto del área metropolitana de Boston, el aeropuerto más importante de Nueva Inglaterra en cuanto a los servicios de larga distancia y una gran puerta de entrada internacional a los EE. UU. para los servicios transatlánticos. Los límites del aeropuerto abarcan aproximadamente 970 hectáreas en el Este de Boston y Winthrop, incluidas aproximadamente 283 hectáreas en el puerto de Boston. El aeropuerto Logan comprende seis pistas, aproximadamente 24 140 metros de pistas para carreteo y aproximadamente 97 hectáreas de plataformas de cemento y asfalto. El aeropuerto Logan tiene cuatro terminales de pasajeros interconectadas (Terminales A, B, C y E), cada una con sus propias instalaciones de emisión de pasajes, reclamo de equipaje y transporte terrestre. El aeropuerto está a menos de cinco kilómetros del centro de Boston y se puede acceder a este por dos líneas de transporte público, cinco líneas de autobuses directas y un sistema de carreteras bien conectadas. Massport brinda el servicio de autobuses Logan Express desde y hacia el aeropuerto Logan para los pasajeros de aéreos y para los empleados de los aparcamientos disuasorios en Braintree, Framingham, Woburn y Peabody. Massport también brinda el servicio urbano Logan Express desde el área de Back Bay de Boston.

Este *ESPR de 2017* pertenece a una serie de documentos de revisión medioambiental anual entregados al secretario de la Oficina Ejecutiva de Energía y Asuntos Medioambientales (Executive Office of Energy and Environmental Affairs, EEA) en cumplimiento con la Oficina de la Ley de Políticas Medioambientales de Massachusetts (Massachusetts Environmental Policy Act, MEPA).[1] Desde 1979, Massport presenta estos documentos para informar los efectos medioambientales acumulados de las operaciones y de las actividades del aeropuerto Logan. El aeropuerto Logan es el primer aeropuerto del país para el que se confeccionó una

1 Capítulo 30 de las leyes generales de Massachusetts, secciones 61-62H. La MEPA se implementa mediante las reglamentaciones publicadas en el Código de Normas de Massachusetts (Code of Massachusetts Regulations, CMR) 301 11.00 (las reglamentaciones de la MEPA).

evaluación medioambiental anual sobre las actividades aeroportuarias y Massport continúa siendo líder en informes medioambientales.

Aproximadamente cada cinco años, Massport confecciona un ESPR, que brinda un panorama histórico y prospectivo del aeropuerto Logan. Los Informes de Datos Medioambientales (Environmental Data Reports, EDR), que se confeccionan anualmente en los intervalos entre los ESPR, brindan una revisión de las condiciones medioambientales para el año que se informa en comparación con el año anterior. Este *ESPR 2017* sigue al *EDR de 2016* e informa sobre las condiciones de 2017 y sobre las condiciones futuras.

El alcance de este documento se estableció mediante la certificación del secretario con fecha del 9 de marzo de 2018, la que se incluye en el Apéndice A, *Certificados y respuestas a los comentarios de la MEPA*. Este *ESPR 2017* cumple con todos los requisitos establecidos en la certificación del secretario de 2018. Este *ESPR 2017* brinda las respuestas detalladas a los comentarios de la certificación del secretario y a las actualizaciones, y compara los datos presentados en el *EDR de 2016* para los siguientes temas:

- Niveles de actividad (incluidas las operaciones de las aeronaves, las actividades de los pasajeros y los volúmenes de carga)
- Planificación aeroportuaria (incluidas las actividades que están en curso y los proyectos venideros)
- Función del aeropuerto Logan en la red de transporte regional
- Acceso terrestre desde y hacia el aeropuerto
- Proyecciones para las operaciones de las aeronaves y para la actividad de pasajeros, y modelos de condiciones futuras de acceso terrestre, de ruido, y de calidad del aire
- Disminución del ruido
- Calidad del aire/Reducción de emisiones
- Calidad del agua/Cumplimiento medioambiental
- Sustentabilidad y resiliencia
- Medidas medioambientales beneficiosas y compromisos de mitigación

Para mejorar la utilidad de este *ESPR 2017* como documento de referencia para los revisores, este informe también presenta datos históricos sobre las condiciones medioambientales en el aeropuerto Logan desde 1990, en las instancias en que hay información histórica disponible. Cuando corresponde y esté disponible, el *ESPR 2017* también incluye actualizaciones hasta el 2018.

EEA n.° 3247

Presentada por

Massachusetts Port Authority
One Harborside Drive, Suite 200S
East Boston, MA 02128

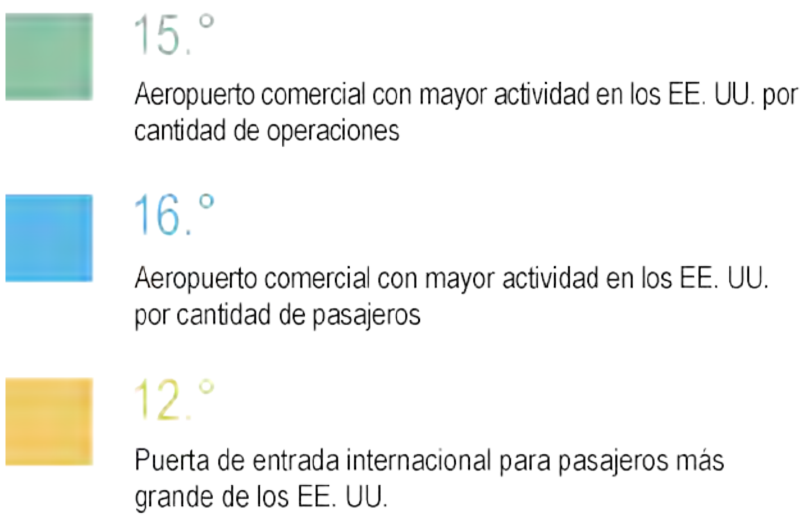
Stewart Dalzell, subdirector
Planificación estratégica y de negocios
(617) 568-3524

Michael Gove, director de proyectos
Planificación estratégica y de negocios
(617) 568-3546

Contexto de la planificación del aeropuerto Logan

El aeropuerto Logan cumple una función clave en las redes de transporte de pasajeros y de mercadería del área metropolitana de Boston y de Nueva Inglaterra. El aeropuerto es uno de los aeropuertos con terreno más limitado del país y está rodeado en tres laterales por el puerto de Boston (consulte las **Figuras 1-3** y **1-4**). Como se muestra en la **Figura 1-2**, el aeropuerto Logan podría caber 14 veces en los límites del Aeropuerto Internacional de Denver.

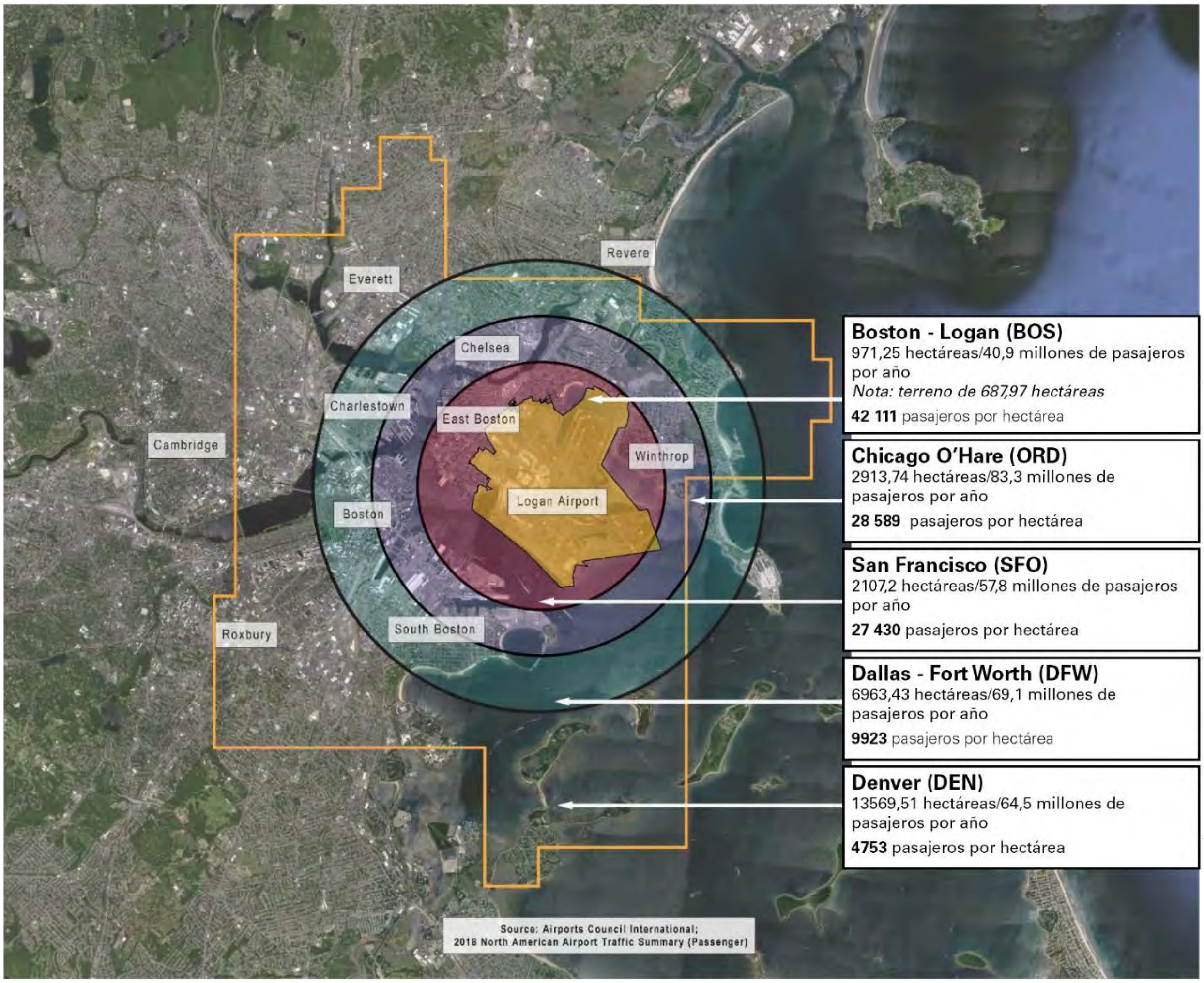
Figura 1-1 Clasificación del aeropuerto Logan, 2017



Fuente: Consejo Internacional de Aeropuertos (Airports Council International, ACI), 2017; EE. UU. Base de datos T-100 del departamento de transporte, 2017.

Nota: Una puerta internacional de los EE. UU. para pasajeros hace referencia a un puerto de ingreso a los EE. UU. para los pasajeros que realizan viajes internacionales. El aeropuerto Logan está clasificado en el puesto n.° 12 entre otros aeropuertos de los EE. UU. con servicio internacional, en cuanto a la cantidad total de pasajeros que se embarcan en vuelos internacionales.

Figura 1-2 Comparación en cuanto al tamaño del aeropuerto Logan y de otros aeropuertos internacionales



Fuente: ACI, Resumen del tráfico aeroportuario norteamericano (pasajeros) de 2018; Massport.

FIGURA 1-3 Vista aérea del aeropuerto

Informe de estado medioambiental y planificación de 2017

Fuente: USGS 2015

FIGURA 1-4 Aeropuerto Logan y alrededores

Informe de estado medioambiental y planificación de 2017

Crecimiento de la actividad de pasajeros y de aeronaves en el aeropuerto Logan

En 2017, los niveles de actividad de pasajeros en el aeropuerto Logan alcanzaron 38,4 millones en todo momento, un aumento del 5,9 por ciento en comparación con 2016. Las operaciones de las aeronaves aumentaron de forma más paulatina, alcanzando un total de 401.371 en 2017, un aumento del 2,6 por ciento en comparación con 2016. Esta tendencia continuó en 2018, y los niveles de actividad de pasajeros alcanzaron un total de 40,9 millones y las operaciones de las aeronaves fueron de 424.024 (**Figura 1-5**) El crecimiento está directamente correlacionado con las fuertes economías nacionales y regionales. Las operaciones de las aeronaves permanecen muy por debajo de las 487.996 operaciones del 2000 y del pico histórico de 507.449 operaciones alcanzadas en 1998 (**Figura 1-6**). El crecimiento más lento de las operaciones de las aeronaves en comparación con los niveles de pasajeros se debe al aumento constante en el tamaño de las aeronaves y a la mejora en los factores de carga de las aeronaves (pasajeros/disponibilidad de asientos).

Figura 1-5 Los niveles anuales de pasajeros en el aeropuerto Logan continúan creciendo más rápidamente que las operaciones de las aeronaves (1990-2018)

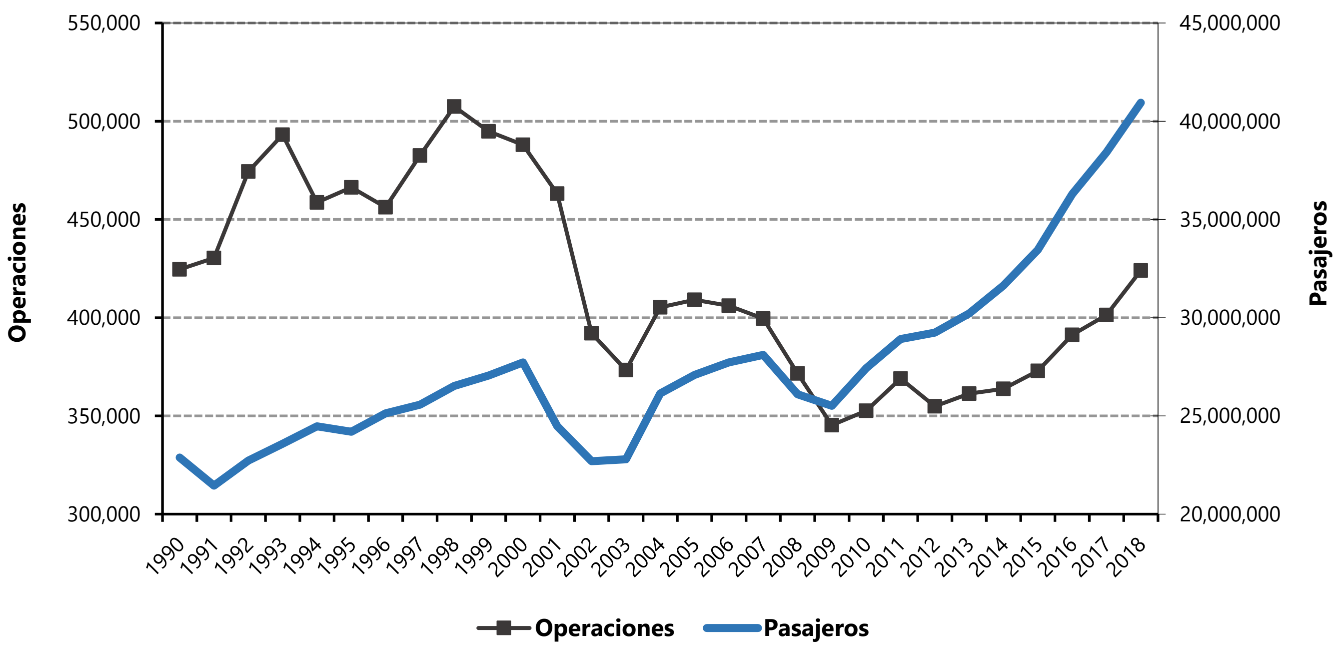


Figura 1-6 Pasajeros y operaciones anuales del aeropuerto Logan, 1990, 1998, 2000, 2016-2018

El crecimiento del aeropuerto Logan es consecuencia de la fuerte economía regional

El crecimiento del aeropuerto Logan puede atribuirse a la fuerte economía local, regional y nacional. Junto a este crecimiento surgen desafíos y Massport cuenta con una estrategia para abordar estos desafíos de modo tal que permitirá que el aeropuerto Logan evolucione de manera sustentable y responsable en cuanto al medioambiente.

El aeropuerto Logan es el aeropuerto más grande de los seis estados de la región de Nueva Inglaterra, que tiene una población de aproximadamente 14,8 millones de residentes. El aeropuerto está ubicado en Massachusetts, que alberga a 6,8 millones de residentes, o el 47 por ciento de la población total de Nueva Inglaterra. El aeropuerto presta servicios a pasajeros de toda Nueva Inglaterra y la principal zona de influencia está compuesta por los siguientes cinco condados de Massachusetts: Essex, Middlesex, Norfolk, Plymouth y Suffolk (que incluye la ciudad de Boston). De acuerdo con las estadísticas disponibles más recientes, 4,4 millones de personas residen en esta área de cinco condados y según las proyecciones, la población dentro del área de influencia aumentará un 0,5 por ciento por año en los próximos 19 años.[2] El área metropolitana de Boston ha mantenido en forma constante una menor tasa de desempleo (3,4 por ciento) que la de la Mancomunidad (3,7 por ciento) y que la del país entero (4,4 por ciento).[3] El aeropuerto no solo atiende a una población en crecimiento, sino también a una población con mayores ingresos. El ingreso *per capita* en 2017 fue de USD 65 941 (dólares estadounidenses en 2009) en el área de servicios principal del aeropuerto, 11,2 por ciento más alta que en la Mancomunidad y 45,5 por ciento más alta que el promedio nacional.[4]

El aeropuerto Logan es un recurso de transporte y económico clave en la región de Nueva Inglaterra, en el estado y en el área metropolitana de Boston, que alberga una gran variedad de industrias. Las industrias con la mayor cantidad de empleados incluyen la atención médica y la asistencia social, los servicios educativos, profesionales, científicos y tecnológicos (que incluyen la creciente industria biotecnológica de Boston).[5] En 2017, Boston fue declarada la ciudad n.° 1 en los EE. UU. por fomentar el crecimiento y la innovación empresarial.[6] El aporte de la innovación y de las nuevas empresas también se evidencia en los cálculos del crecimiento económico desde finales de 2017 hasta la fecha y refleja tendencias al aumento de empleos y de industrias de alta tecnología.

Además de respaldar el crecimiento y éxito económico del estado, el aeropuerto Logan y la industria aeroportuaria son elementos importantes para la economía estatal y regional. La *Actualización del estudio del impacto económico del aeropuerto estatal de Massachusetts,* realizada por el Departamento de Transporte de Massachusetts (Massachusetts Department of Transportation, MassDOT) en 2014 y

2 Woods & Poole Economics, Inc. 2018. Complete Economic and Demographic Data Source (CEDDS).
3 Oficina de estadística laboral (Bureau of Labor Statistics) de los EE. UU. 2017.
4 Woods & Poole Economics, Inc. 2018.
5 Oficina de Censos a través de Data USA. Boston-Cambridge, Newton, perfil del área metropolitana MA-NH, wwww.datausa.io.
6 Oficina Fundación de la Cámara de Comercio (Chamber of Commerce Foundation) y 1776. 2017. *Innovation That Matters*.

actualizada más recientemente en 2019,[7] calcula que los aeropuertos de Massport contribuyen con aproximadamente USD 23,1 mil millones en producción a la economía de Massachusetts anualmente. De esta producción, el 71 por ciento se debe solo al aeropuerto Logan.[8] La producción total incluye negocios dentro del aeropuerto, construcción, visitantes y efectos multiplicadores (consulte la **Figura 1-7**).[9] El aeropuerto Logan respalda más de 162.000 puestos de trabajo directos e indirectos, al mismo tiempo que genera aproximadamente USD 16,3 mil millones por año en producción económica total.[10] En 2017, se contrataron más de 20 000 personas en el aeropuerto Logan. Esto incluyó aproximadamente 1285 miembros del personal y empleados administrativos del aeropuerto Massport.[11]

El aeropuerto Logan se considera un aeropuerto de origen y destino (O&D))[12] tanto nacional como internacionalmente, lo que significa que, aproximadamente, el 90 por ciento de los pasajeros del aeropuerto Logan inician o finalizan su viaje en el área de Nueva Inglaterra. Los aeropuertos principales, como el de Atlanta o Chicago, atienden a muchos más pasajeros anualmente, pero en comparación con los aeropuertos de O&D, como el aeropuerto Logan, pasa un porcentaje mayor de pasajeros en tránsito en los aeropuertos principales a través de los vuelos de conexión. El aeropuerto Logan es uno de los aeropuertos grandes con crecimiento más rápido de los EE. UU. en cuanto a la cantidad de pasajeros en los últimos cinco años.[13] En 2017, el tráfico de pasajeros aéreos en los EE. UU. creció un 3,5 por ciento, mientras que el aeropuerto Logan experimentó un crecimiento de pasajeros del 5,9 por ciento.[14] Los pasajeros aéreos internacionales contribuyen con una parte sustancialmente mayor a la economía regional que los pasajeros con destinos nacionales. En 2017, el aeropuerto Logan dio la bienvenida a 1,6 millones de visitantes extranjeros, un aumento del 4,8 por ciento en comparación con los niveles de 2016.[15] El nuevo servicio internacional ha aportado, solo en los últimos cinco años, más de USD 1,3 mil millones por año a la economía local y USD 49 millones en nuevos ingresos incrementales y en ingresos fiscales por ventas.[16]

---

7 MassDOT. 2014. *Actualización del estudio del impacto económico del aeropuerto estatal de Massachusetts.*http://www.massdot.state.ma.us/portals/7/docs/airportEconomicImpactSummary.pdf.

8 *Ibíd*.

9 Los efectos multiplicadores se refieren a la recirculación del dinero en la economía local después de haber sido gastados inicialmente por el aeropuerto, sus locatarios o los turistas. Esta recirculación aumenta el impacto general de las operaciones del aeropuerto en la economía local.

10 División de Aeronáutica de MassDOT. 2019. *Actualización del estudio del impacto económico del aeropuerto estatal de Massachusetts.* https://www.mass.gov/files/documents/2019/03/25/AeroEcon_ImpactStudy_January2019.pdf.

11 Massport, 2018. *Informe integral anual final de 2018 de la Autoridad Portuaria de Massachusetts.* https://www.massport.com/media/3029/mpa-fy18-cafr-final.pdf. Tabla S-11.

12 El "tráfico de origen y de destino" se refiere al tráfico de los pasajeros que se origina o que termina en un aeropuerto o en un mercado en particular. Un mercado de O&D fuerte, como Boston, genera una demanda local de pasajeros significativa, ya que muchos pasajeros inician y terminan su viaje en ese mercado. El tráfico de O&D es diferente al tráfico de conexión, que es tráfico de pasajeros que no inician ni terminan en el aeropuerto, sino que solo hacen conexiones en el aeropuerto en ruta hacia otros destinos.

13 Entre 2012 y 2017, el aeropuerto Logan fue el 9.° aeropuerto con crecimiento más rápido en los EE. UU. en términos de tráfico local de O&D (encuesta de O&D del Departamento de Transporte [Department of Transportation, DOT] de los EE. UU.).

14 ACI. 2017. Resumen del tráfico en los aeropuertos norteamericanos del ACI http://www.aci-na.org/content/airport-traffic-reports.

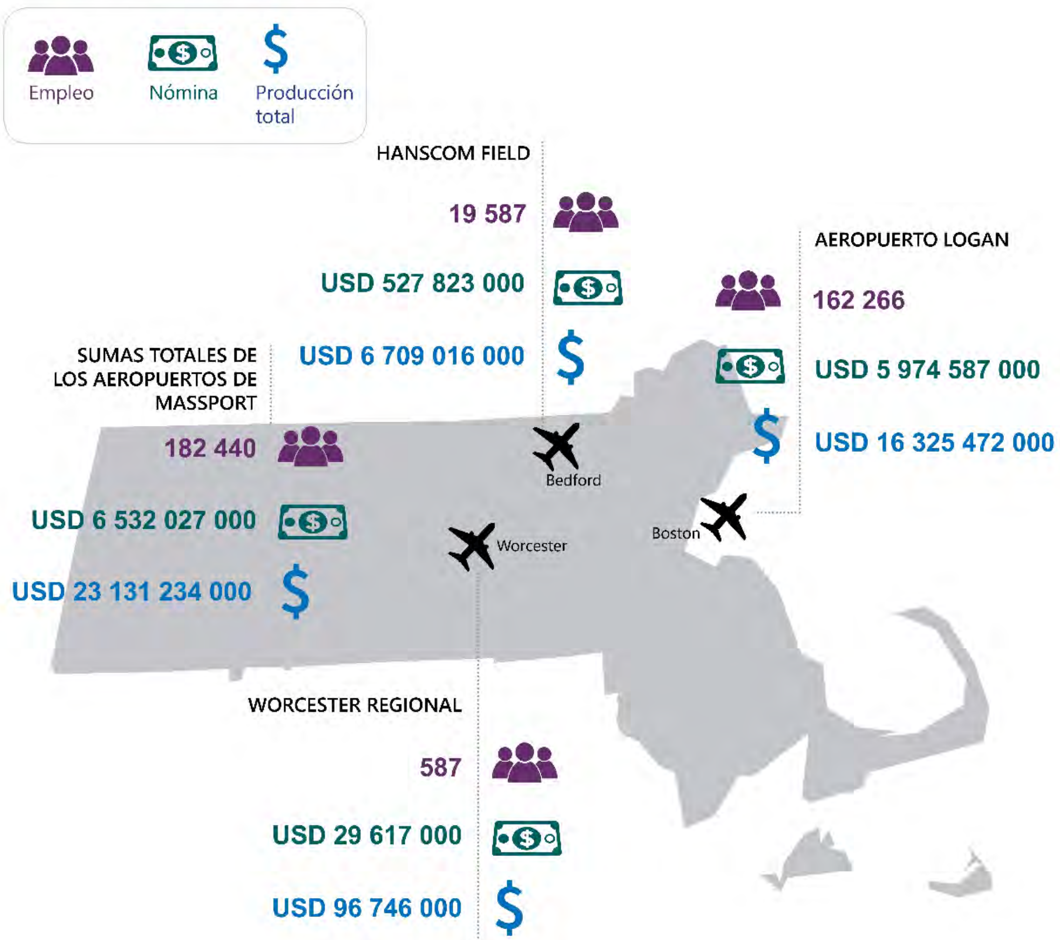
15 Oficina de Turismo y Congresos de Greater Boston. 2018. Visitas extranjeras. https://www.bostonusa.com/media/statistics-reports/overseas-visitation/.

16 InterVISTAS. 2016. *Impacto económico de las rutas internacionales recientes.*.

A LO LARGO DE LOS AÑOS, LA ECONOMÍA REGIONAL Y EL INTERCAMBIO DE CONOCIMIENTOS EN LAS INDUSTRIAS DE TECNOLOGÍA DE LA INFORMACIÓN, CIENCIAS BIOLÓGICAS, FINANZAS, EDUCACIÓN Y ATENCIÓN MÉDICA HAN IMPULSADO EL AUMENTO EN LA CANTIDAD DE PASAJEROS EN EL AEROPUERTO LOGAN. LA EXPANSIÓN DE LAS RUTAS INTERNACIONALES RESPALDA LAS OPORTUNIDADES ECONÓMICAS QUE TIENE MASSACHUSETTS AL PERMITIR ALCANZAR DECENAS DE MERCADOS EN TODO EL MUNDO Y MEJORAR LA COMPETITIVIDAD YA QUE ES UNA UBICACIÓN DE PRIMER NIVEL GLOBAL PARA LOS NEGOCIOS, LA INVESTIGACIÓN, LA EDUCACIÓN, LA TECNOLOGÍA Y EL TURISMO.

Fuente: *Mass*Benchmarks. 2018. *The Journal of the Massachusetts Economy, Volume 20 Issue 2.*

Figura 1-7 Impacto económico total de los aeropuertos de Massport



Fuente: MassDOT, Massachusetts Statewide Airport Economic Impact Study Update, 2019.
Notas: "Totales para Massachusetts" se refiere a la producción económica total de todos los aeropuertos de Massachusetts.

Horizonte de planeación futura

Como parte de sus medidas de planificación estratégica en curso, Massport confecciona proyecciones de las operaciones de las aeronaves y de los niveles de actividad de los pasajeros cada unos pocos años. Este ESPR evalúa las condiciones de las operaciones y medioambientales futuras asociadas con una proyección de 50 millones de pasajeros aéreos anuales y 486.000 operaciones de aeronaves anuales en los próximos 10 a 15 años (el horizonte de planificación futura). Las proyecciones de Massport son congruentes con la proyección del área de la terminal de la Administración Federal de Aviación (Federal Aviation Administration, FAA).

Inversiones de Massport en el aeropuerto Logan

Massport está comprometido con la evaluación y con la implementación de mejoras en el aeropuerto Logan, con la seguridad, con la eficacia operativa y con el acceso desde y hacia el área metropolitana de Boston, mientras controla atentamente los efectos medioambientales de las operaciones del aeropuerto Logan. Massport mejora continuamente las instalaciones del aeropuerto Logan.

Actualmente, Massport está enfocado en mejorar la experiencia de los pasajeros y de los usuarios del aeropuerto Logan en todos los aspectos de las instalaciones. Los proyectos del área de la terminal recientes y en curso brindan una conectividad posterior a la seguridad sin inconvenientes entre las terminales y mejoras al sistema de proceso de pasajeros a través de las áreas de verificación de seguridad consolidadas. El acceso desde y alrededor del aeropuerto Logan es la nueva área crítica de mejora.

Para mejorar el acceso al aeropuerto así como para aliviar la congestión en las carreteras del aeropuerto, Massport continúa mejorando los medios masivos de transporte (high-occupancy vehicle, HOV) y las instalaciones de Logan Express, implementando proyectos de conectividad de las carreteras del aeropuerto y la línea Blue de la Autoridad de Transporte de la Bahía de Massachusetts (Massachusetts Bay Transportation Authority, MBTA)/entre las terminales, construyendo nuevas instalaciones de estacionamiento consolidadas para que las empresas de red de transporte (transportation network company, TNC; como Uber y Lyft) dejen o recojan pasajeros, y construyendo nuevas instalaciones de estacionamiento, que ayudarán a reducir la cantidad de viajes para recoger/dejar pasajeros. Massport continúa trabajando con la FAA para mejorar la seguridad en la zona de operaciones a través de una variedad de mejoras en la seguridad del área de las pistas (runway safety area, RSA) y de simplificaciones en la geometría del campo de aviación.

Estrategia de Massport para el manejo de las condiciones medioambientales actuales y futuras

Massport comprende su función como propietario y operador del aeropuerto Logan y como responsable del medioambiente. Este *ESPR 2017* documenta las condiciones actuales en el aeropuerto, en función de las proyecciones de las actividades de los pasajeros y de las operaciones de las aeronaves, modela las futuras condiciones y describe los planes de Massport para manejar de manera responsable el crecimiento en el aeropuerto al mismo tiempo que se minimizan los impactos medioambientales.

La estrategia de Massport de minimizar los impactos es una combinación de lo siguiente:

- Iniciativas de políticas y mejoras en la infraestructura.
- Inversiones en sustentabilidad y resiliencia.
- Apoyo y alianzas con la comunidad.

Como se describió anteriormente, debido a la fuerte economía, los niveles de actividad de pasajeros y de operaciones de las aeronaves en el aeropuerto Logan han aumentado y se proyecta que continuará esta tendencia a través del horizonte de planeación futura, y que posiblemente alcancen 50 millones de pasajeros aéreos anuales en los próximos 10 a 15 años.

El éxito de Worcester Regional Airport ayuda a abastecer este crecimiento económico regional y a la demanda de los viajes aéreos. En Worcester Regional Airport se observó un aumento en la cantidad de pasajeros de un 32 por ciento en 2018 en comparación con 2017, y se informó un total de aproximadamente 600.000 pasajeros desde 2013 hasta 2018. En los últimos cinco años, Worcester Regional Airport ha experimentado una tasa de crecimiento promedio del 30 por ciento por año. Massport continúa invirtiendo en Worcester Regional Airport. Junto con la ciudad de Worcester, Massport ya ha comenzado una inversión de USD 100 millones a 10 años para revitalizar y atraer operaciones comerciales en Worcester Regional Airport. Las inversiones incluyen un sistema de aterrizaje instrumental de categoría (CAT) III (alrededor de USD 32 millones) que se pagaron con subvención federal y fondos de Massport. Además, jetBlue Airways, American Airlines y Delta Air Lines anunciaron un nuevo servicio al John F. Kennedy International Airport (JFK) de Nueva York, al Philadelphia International Airport y al Detroit Metropolitan Wayne County Airport, respectivamente.

La estrategia de Massport de manejar el crecimiento del aeropuerto Logan de manera responsable en cuanto al medioambiente se centra en iniciativas que Massport puede controlar o en las que pueden influir. Por ejemplo, la mayoría de los impactos medioambientales asociados con el aeropuerto Logan corresponden a las operaciones de las aeronaves y a las actividades relacionadas con estas, las que Massport no puede controlar, pero hace un gran esfuerzo por influenciarlas.

Las próximas secciones destacan la estrategia de Massport y los éxitos en cuanto a la calidad del aire, al acceso terrestre y a la disminución del ruido, así como su programa de sustentabilidad. A lo largo de este informe, las iniciativas de sustentabilidad se destacan con una hoja de sustentabilidad.

En la **Tabla 1-1** se brinda un resumen de condiciones medioambientales clave en el aeropuerto Logan en 2017 y condiciones futuras previstas y se documenta el enfoque planeado de Massport para limitar los efectos sobre el medioambiente y sobre la comunidad.

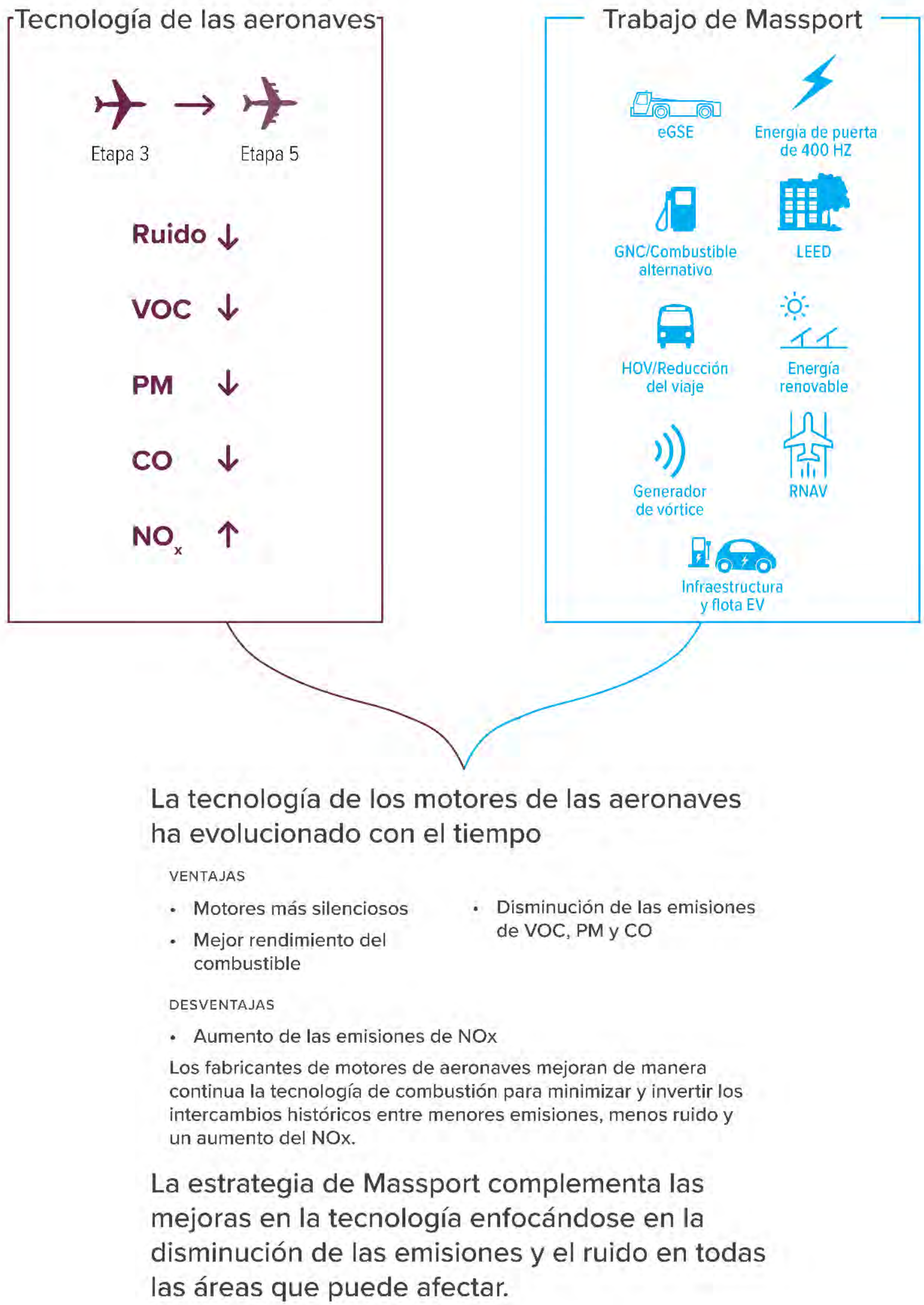
Tabla 1-1 Resumen de condiciones medioambientales clave, 2017, y horizonte de planeación futura y estrategia de Massport

Categoría Medioambiental	2017	Horizonte de planeación futura	Estrategia de Massport
Acceso terrestre	■ Aumentos promedio del tráfico diario y de las millas viajadas por vehículo (vehicle miles traveled, VMT) en las carreteras del aeropuerto. ■ Las empresas de la red de transporte (TNC), como Uber y Lyft, afectan otros modos de acceso y contribuyen a la congestión para ingresar y para retirarse del aeropuerto.	■ Al reconocer los desafíos actuales, Massport planea continuar implementando cambios de políticas de transporte y modificaciones en la infraestructura, con el objetivo de disminuir las VMT diarias en el aeropuerto.	■ Comprometerse para reducir la congestión y las emisiones asociadas al aumentar los viajes de los medios de transporte masivos (HOV), al reducir la actividad no productiva de las TNC (viajes de un solo tramo vacíos), al aumentar el -estacionamiento dentro del aeropuerto para reducir los viajes para dejar/recoger pasajeros, y para expandir el servicio y las instalaciones de Logan Express. ■ Evaluar e implementar mejoras en la infraestructura dentro del aeropuerto para reducir la congestión.
Ruido	■ La curva del nivel promedio de sonido durante el día/la noche (Day-Night Average Sound Level, DNL) aumentó. ■ La cantidad total de personas que residen en la curva del DNL de 65 dB aumentó en 483 personas, de 7450 en 2016 a 7933 en 2017. ■ La cantidad total de personas que residen en la curva del DNL de 65 dB en 2017 es de alrededor del 82 por ciento menos que la cantidad en 1990, debido a la mejora en la tecnología de los motores.	■ Según las proyecciones, la curva del DNL de 65 dB aumentará levemente debido al crecimiento previsto en las operaciones. La cantidad total de personas que residen en la curva del DNL de 65 dB también aumentaría. Este crecimiento se dará en áreas que ya han sido protegidas contra el sonido por Massport o que fueron elegibles para la protección contra el sonido en el pasado. ■ Según las proyecciones, la cantidad de personas que residen en la curva del DNL de 65 dB será de alrededor del 81 por ciento menos en el horizonte de planeación futura, en comparación con 1990.	■ Continuar trabajando con la Administración Federal de Aviación (FAA) para comprender mejor las implicancias de la navegación basada en el desempeño (como la navegación de área [RNAV]) y evaluar las estrategias para abordar las preocupaciones de la comunidad. ■ Continuar buscando fondos de la FAA para las residencias que califican para la insonorización. ■ Continuar implementando medidas para disminuir el ruido, como restricciones en el uso de las pistas y la reducción del carreteo con los motores encendidos. ■ Coordinar con las partes interesadas a través del Comité Asesor de la Comunidad de Massport para identificar oportunidades para reducir el ruido.

Tabla 1-1 Resumen de condiciones medioambientales clave, 2017, y horizonte de planeación futura y estrategia de Massport (cont.)

Categoría Medioambiental	2017	Horizonte de planeación futura	Estrategia de Massport
Calidad del aire	Las emisiones modelizadas de compuestos orgánicos volátiles (volatile organic compounds, VOC) y de partículas (particulate matter [PM]; PM10(PM2,5) disminuyeron en 2017 en comparación con 2016. Las emisiones modelizadas de óxidos de nitrógeno (NO_x) aumentaron en el mismo período, debido, en gran parte, a las diferencias en las mezclas de flotas de aeronaves y a los aumentos en la cantidad de aterrizajes y despegues (landings and takeoffs, LTO) y en los tiempos de carreteo. Las emisiones de gases de efecto invernadero (Greenhouse gas, GHG) también aumentaron de 2016 a 2017.	Según las proyecciones, las emisiones de VOC; CO y PM10/PM2,5 disminuirán. Según las proyecciones, las emisiones de NO_x aumentarán debido a cambios en las flotas de las aeronaves (es decir, un mayor uso de aeronaves más silenciosas, pero de mayor emisión de $NO_{x)}$ junto con el aumento previsto en las operaciones de las aeronaves en el aeropuerto. Según las proyecciones, aumentarán las misiones de GHG.	Reemplazar el equipo de servicio terrestre (ground service equipment, GSE) que funciona con gasolina y con diésel por equipos que sean completamente eléctricos (electric GSE, eGSE) para finales del 2027 (según estén disponible comercialmente). Implementar iniciativas adicionales para aumentar el uso del HOV, continuar reduciendo las emisiones de los vehículos de la flota de Massport y fomentar el uso de vehículos con combustible alternativo. Continuar implementando proyectos para la eficacia de la energía, lo que incluye actualizaciones a la Planta central de calefacción y refrigeración, y aumentar el uso de energía renovable, como las instalaciones de energía solar y eólica, en el aeropuerto.

Figura 1-8 La tecnología de los motores de las aeronaves ha evolucionado con el tiempo



Estrategia para la calidad del aire

Las emisiones totales de todas las fuentes relacionadas con el aeropuerto Logan son menores a las de hace una década, a excepción del NO_x. Esta tendencia hacia la disminución es congruente con el objetivo de larga data de Massport de adaptarse a las demandas del aumento de pasajeros y de los niveles de actividad de las cargas con menos operaciones de aeronaves y menos emisiones en donde sea posible. En comparación con el 2016, los cambios en las emisiones atmosféricas en el 2017 están perfectamente dentro de los valores dado el repunte correspondiente de las operaciones de las aeronaves.

Efecto de la tecnología de los motores de las aeronaves en el NO_x

Las emisiones de las aeronaves continúan representando la fuente más grande (94 por ciento) de NO_x en el aeropuerto Logan, seguidas por otras fuentes (3 por ciento), el equipo de servicio terrestre (GSE) (2 por ciento) y por los vehículos con motor (1 por ciento). Esta es una distinción importante, ya que Massport no tiene ningún control sobre las emisiones de las aeronaves, que son la gran mayoría del total.

Para reducir las cantidades y los costos del uso de combustible, los diseñadores y los fabricantes de los motores de las aeronaves están produciendo motores que ahorran más combustible (es decir, que queman menos combustible). Esto se logra mejorando el desempeño del motor con tecnologías de combustión mejoradas, mayor poder de propulsión y menor desgaste del motor. También se están diseñando aeronaves para disminuir la quema de combustible con avances en la aerodinámica de las alas y del cuerpo de las aeronaves, con materiales de aleaciones livianas y mejores medios de navegación. Se prevé que estas nuevas tecnologías y la reducción en la quema de combustible reduzcan las emisiones, reduzcan el ruido y moderen el crecimiento de las emisiones de NO_x en el futuro.

Debido a que Massport no tiene un control directo sobre las operaciones de las aeronaves ni de las elecciones de las flotas de las aerolíneas, continúa enfocándose en las áreas que controla para maximizar la reducción de emisiones de estas fuentes sobre las que tiene posibilidades de influenciar. La estrategia para el manejo de la calidad del aire de Massport para el aeropuerto Logan se enfoca en la reducción de las emisiones de las fuentes relacionadas con el aeropuerto, además de continuar innovando en formas de lograr las reducciones de las emisiones en todo el aeropuerto. Massport ha establecido una cantidad de metas y objetivos para abordar las emisiones atmosféricas de las operaciones del aeropuerto, incluida la minimización de las emisiones relacionadas con el aeropuerto a través de la reducción de las emisiones de los GSE y de la flota de vehículos de Massport. Massport está enfocado en las siguientes iniciativas:

- **Brindar infraestructura y fomentar prácticas que respalden las reducciones de las emisiones de las aeronaves.**
  - Massport brinda aire preacondicionado (pre-conditioned air, PCA) y energía de 400 hertz (Hz) en todas las puertas de contacto de las aeronaves para reducir el tiempo en que las aeronaves tienen los motores encendidos y el uso de la unidad de potencia auxiliar (auxiliary power unit, APU) cuando no hay suficientes puertas de embarque disponibles.
  - Massport fomenta los procedimientos de carreteo con un solo motor por parte de las aerolíneas para reducir tanto el ruido como las emisiones atmosféricas.

- Uso de remolcadores y de cintas de equipaje alimentados a batería para la flota del servicio terrestre de Delta Air Lines en la Terminal A.

- **Maximizar el uso del HOV y reducir los viajes en autos con un solo pasajero, especialmente los viajes para recoger/dejar pasajeros, y el uso de vehículos privados por parte de los pasajeros desde y hacia el aeropuerto.**
  - Massport implementa una amplia estrategia para el HOV y mejoras en el transporte terrestre (consulte la siguiente sección, Estrategia de acceso terrestre, para obtener detalles).

- **Reducir las emisiones de las flotas que operan en el aeropuerto Logan**
  - Massport está facilitando el reemplazo del GSE que funciona con gasolina y con diésel por equipos que sean completamente eléctricos (eGSE) para finales de 2027 (según estén disponibles comercialmente). En 2018, la La Agencia de Protección Medioambiental (Environmental Protection Agency, EPA) de los EE. UU. otorgó una subvención de USD 541.817 a Massport para reemplazar el GSE que funciona con gasolina y diésel en el aeropuerto Logan. Esta subvención se usará junto con una subvención del programa Bajas Emisiones Voluntarias en Aeropuertos (Voluntary Airport Low Emissions, VALE) de la FAA que Massport recibió en el otoño de 2018 para instalar estaciones de carga de eGSE como parte del Proyecto de optimización de la Terminal B.
  - Massport continúa con su programa de incentivo "Clean-Air-Cab" (Taxi que permite un aire limpio) para que se utilicen vehículos con combustible alternativo (alternative fuel vehicles, AFV).

- **Brindar infraestructura para respaldar los combustibles alternativos, incluido el gas natural comprimido (GNC) y la electricidad**
  - Massport continúa operando una de sus estaciones minoristas de GNC más grandes de Nueva Inglaterra, que está abierta al público. En 2017, la estación de GNC dispensó aproximadamente el equivalente a 25 234 galones por mes para todos los vehículos de la flota de Massport (vehículos que no pertenecen a Massport también usaron GNC).
  - Massport respalda los sistemas estándar actuales y futuros para los vehículos eléctricos (electric vehicles, EV) que se enchufan. Por ejemplo, el centro de alquiler de automóviles (Rental Car Center, RCC) en el área de servicio sudoeste (Southwest Service Area, SWSA) incluye la infraestructura necesaria para instalar futuras estaciones para enchufar EV.
  - Massport ha instalado 13 estaciones para enchufar EV, para abastecer a un total de 26 vehículos en Central Garage y en las zonas de estacionamiento de la Terminal B. Massport está comprometido con el aumento de la disponibilidad de las estaciones para enchufar EV para que el 150 por ciento de esta demanda esté disponible en todas las instalaciones en todo momento.
  - Actualmente, hay 64 estaciones de carga instaladas en el aeropuerto Logan y en sitios de Logan Express, y está previsto que se instalarán 62 estaciones más para 2020.

- **Reducir las emisiones de los vehículos de la flota de Massport**
  - Massport continúa operando y aumentando su flota de 54 AFV/vehículos con energía alternativa (alternative power vehicle, APV) en los autobuses de enlace del aeropuerto. Massport también estableció una política de adquisición de vehículos en 2006 que exige que se tengan en cuenta los AFV cuando se realicen compras.
- **Reducir emisiones asociadas a los edificios de Massport, incluidas las necesidades energéticas**
  - Massport se ha comprometido a alcanzar la certificación Leadership in Energy and Environmental Design (LEED®) para los edificios elegibles, según corresponda.
  - Massport continúa invirtiendo en instalaciones de energía renovable dentro del aeropuerto (solar/eólica).

Estrategia para el acceso terrestre

Un foco clave de Massport es abordar la congestión de las carreteras dentro del aeropuerto con una combinación de cambios en las políticas y con mejoras en la infraestructura. La importancia de aliviar la congestión es doble: es necesario permitir que se continúen operando de manera segura y eficiente las operaciones terrestres del aeropuerto y es necesario reducir los impactos en el medioambiente. Mejorar las opciones de transporte multimodal, y brindar una infraestructura moderna y flexible es una forma mediante la cual un aeropuerto puede reducir las emisiones de gases de efecto invernadero (GHG) y de mejorar su huella ecológica.

Massport reconoce las diferentes formas de llegar y al aeropuerto y de partir de este, y cuenta con un plan estratégico para aumentar la modalidad del HOV en un 40 por ciento para 2027. Además, manejar el crecimiento de las TNC es esencial para tener capacidad para el volumen del tráfico dentro del aeropuerto y para fomentar los servicios del HOV. Las reducciones de las posibles emisiones son una razón por la que Massport está comprometido con un objetivo a largo plazo para fomentar y respaldar el HOV público y privado, y los servicios de viajes compartidos dirigidos a los pasajeros aéreos, a los usuarios del aeropuerto y a los empleados. Otros beneficios incluyen los siguientes:

- Reducir la congestión en las carreteras de las terminales y en las aceras de las áreas para recoger/dejar pasajeros.
- Aliviar las restricciones en las instalaciones de estacionamiento limitadas.
- Servicio al cliente (brindar una variedad de opciones de transporte para las diferentes características demográficas de los viajeros).

Las iniciativas descritas a continuación mejorarán las operaciones en las carreteras, así como la calidad de las emisiones atmosféricas. Se prevé que estos cambios permitirán que Massport reduzca las millas viajadas por vehículos (VMT) en el futuro a pesar del aumento de los niveles de actividad de los pasajeros. Se prevén los siguientes cambios en las políticas:

- **Mejoras al servicio suburbano de Logan Express**
  - Aumento del servicio Braintree de Logan Express de dos a tres viajes por hora (implementado en mayo de 2019).
  - Agregar alrededor de 1000 espacios en el estacionamiento Framingham.
  - Construir hasta 3000 espacios de estacionamiento con estructura en Braintree, el que está alcanzando su capacidad.
  - Brindar estado de prioridad en la cola de seguridad para los usuarios de Logan Express Back Bay (implementado en mayo de 2019).
  - Ejecutar una campaña de publicidad sostenida para respaldar la estrategia de Logan Express y para aumentar los viajes.
  - Implementar la emisión de boletos electrónicos para Logan Express.
  - Evaluar las nuevas ubicaciones suburbano de Logan Express, con un plan para abrir al menos un sitio nuevo.
  - Explorar las conexiones de destino final de las TNC. [17]
  - Renombrar los sitios de Logan Express como terminales remotas.
  - Continuar monitoreando la capacidad de estacionamiento en todos los sitios de Logan Express.
- **Línea Silver de la MBTA**
  - Massport adquirió ocho autobuses de la línea Silver en 2005 y los opera la MBTA, y Massport paga los costos operativos. Massport tiene previsto adquirir ochos autobuses más de la línea Silver, lo que daría un total de 16 autobuses, para aumentar la frecuencia.
- **Servicio urbano de Logan Express**
  - Cambiar la ubicación para recoger/dejar pasajeros de la estación Copley a Back Bay (implementado en 2019).
  - Descuento en la tarifa de un solo trayecto de USD 7,50 a USD 3,00 (implementado en mayo de 2019).
  - Servicio gratuito desde el aeropuerto Logan (implementado a los principios de 2019).
  - Poner a prueba estado de prioridad en la cola de seguridad para los usuarios (implementado en 2019).
  - Llevar a cabo campañas publicitarias para respaldar el aumento de los viajes (en curso).
  - Implementar la emisión de boletos electrónicos para Logan Express.
  - Implementar un segundo servicio urbano de Logan Express en North Station.

17 Las personas que se encuentran a una distancia de 0,5 a 1 milla de una instalación de Logan Express conforman el grupo con mayores probabilidades de usar las TNC para realizar el trayecto entre la instalación y sus hogares.

- **Plan de manejo de TNC**
  - Facilitar el flujo de pasajeros y los viajes compartidos al trasladar la actividad de recoger/dejar pasajeros de las TNC a nuevas áreas especialmente destinadas a tal fin en Central Garage.
  - Implementar el flujo constante de pasajeros[18] de las TNC para que los conductores que dejan un pasajero puedan retirarse con un pasajero más fácilmente.
  - Introducir incentivos para los viajes compartidos de las TNC para reducir los vehículos de TNC en los ingresos/las salidas al aumentar la cantidad de pasajeros en los vehículos.
  - Adoptar una nueva estructura para las tarifas de las TNC para respaldar las estrategias de los HOV, alentar los viajes compartidos y reducir la congestión en los ingresos/las salidas.
  - Optimizar las operaciones de las TNC dentro del aeropuerto a través del informe de datos, de las herramientas de cumplimiento y de los nuevos productos de las TNC.
- **Mejoras en la infraestructura**
  - Mediante estudios en curso de las posibles situaciones de crecimiento futuro y de los posibles impactos en las operaciones terrestres, Massport ha identificado la necesidad de nuevas modificaciones a la infraestructura como complemento a los cambios en las políticas para permitir que las áreas de las carreteras y de las aceras continúen funcionando adecuadamente y para minimizar el tiempo que los vehículos están parados con los motores encendidos y las emisiones asociadas.
  - Se tendrán en cuenta una serie de alternativas para la infraestructura para su implementación en los próximos 10 a 15 años. Las opciones para tener en cuenta podrían incluir carriles especiales dentro del aeropuerto para los autobuses del HOV, la creación de un centro de transporte de diferentes modalidades con servicio de autobuses a las terminales, la construcción de un transporte hectométrico automatizado (Automated People Mover, APM) o alguna combinación de estos y otras mejoras. Estos conceptos se describirán en las futuras presentaciones de EDR/ESPR y es posible que se entreguen primero para su revisión en virtud de la Ley de Políticas Medioambientales de Massachusetts (Massachusetts Environmental Policy Act, MEPA) o de la Ley de Política Medioambiental Nacional (National Environmental Policy Act, NEPA) a medida que esos conceptos evolucionen.

18 El flujo constante de pasajeros permite que los conductores que dejan pasajeros instantáneamente recojan otros pasajeros sin la necesidad de dar vueltas en el aeropuerto o de retirarse vacíos.

Estrategia para el ruido

Massport se esfuerza por minimizar los efectos del ruido de las operaciones del aeropuerto Logan en sus vecinos mediante diferentes programas, procedimientos, estudios y demás herramientas para la disminución del ruido. En el aeropuerto Logan, Massport implementa uno de los programas de disminución del ruido de mayor duración y más extensivos de cualquier aeropuerto del país. El programa integral de disminución del ruido incluye una Oficina para la Disminución del Ruido especializada, un sistema de monitoreo del ruido y de operaciones (Noise and Operations Monitoring System, NOMS) de avanzada, programas de protección contra el sonido para casas y escuelas, restricciones de horarios y de pistas para los aviones más ruidosos, procedimientos de prueba de motores en tierra y rastreo de vuelos diseñado para optimizar las operaciones sobre el agua (especialmente durante las horas de la noche). La población puede dejar asentadas quejas por ruido por teléfono o en línea a través del sitio web de Massport.[19]

La base del programa contra el ruido de Massport son las *Normas y Reglamentaciones para la disminución del ruido en el aeropuerto Logan*[20] (las Normas contra el ruido), que rigen desde 1986. La Oficina para la Diminución del Ruido de Massport se encarga de implementar medidas para la disminución del ruido y de monitorear, generalmente, las quejas de la comunidad y otros aspectos de los efectos del ruido de las operaciones del aeropuerto Logan.

Massport está enfocado en las siguientes iniciativas para la disminución del ruido:

- **Asociaciones con aerolíneas y con la FAA**
    - En octubre de 2018, jetBlue Airways (la aerolínea con mayor cantidad de operaciones en el aeropuerto Logan) anunció planes para modernizar su flota de aerobuses más antigua con generadores de vórtices, que reducen el ruido tonal al acercarse. Este movimiento refleja la asociación entre Massport y las aerolíneas para reducir el ruido de las aeronaves para beneficiar a las comunidades circundantes. A medida que las aerolíneas modernizan las aeronaves y hacen la transición a los nuevos modelos de la familia A320, se prevé que la cantidad de aeronaves que operan en el aeropuerto Logan sin generadores de vórtices disminuya. Para obtener más información, consulte un comunicado de prensa en el que se analizan los generadores en el Capítulo 6, *Disminución del ruido*.

Imagen de un dispositivo generador de vórtices por

19 Massport. Quejas por ruidos. http://www.massport.com/logan-airport/about-logan/noise-abatement/complaints/.

20 Las Normas y Reglamentaciones para la Disminución del Ruido en el aeropuerto internacional Logan, vigentes a partir del 1 de julio de 1986, se codifican como código 740 de las normas de Massachusetts (Code of Massachusetts Regulations, CMR) 24.00 et seq (también denominadas Normas contra el ruido).

- El 7 de octubre de 2016, Massport y la FAA firmaron un memorando de entendimiento (Memorandum of Understanding, MOU)[21] para darle un marco al proceso para el análisis de oportunidades para reducir el ruido mediante cambios o enmiendas a la navegación basada en el rendimiento (performance based navigation, PBN), incluida la navegación de área (RNAV). Esta colaboración es el primer programa en el país entre la FAA y un operador aeroportuario para entender mejor lo que implica la PBN y para evaluar las estrategias para abordar las preocupaciones de la comunidad. El líder técnico es el Instituto de Tecnología de Massachusetts (Massachusetts Institute of Technology, MIT). El Bloque 1 se completó a finales de 2017 y se hicieron recomendaciones a la FAA. Actualmente, el MIT está llevando a cabo el análisis del Bloque 2.
- La flota que opera en el aeropuerto Logan está compuesta en un 80 por ciento por aeronaves de fase 4 y en un 18 por ciento por aeronaves de fase 5 (las de fase 5 son las más silenciosas), muy por encima de los motores de fase 3, exigidos como mínimo por la FAA.
- Massport continúa prohibiendo el uso de la pista 4L para las salidas y de la pista 22R para los arribos desde las 11:00 p. m. hasta las 6:00 a. m., maximizando las operaciones sobre el agua tarde a la noche, usando las pistas 15R y 33L, y restringiendo el aumento del volumen de los motores y el uso de la APU a la noche.
- Massport continúa alentando el uso voluntario del carreteo con uso reducido de motores cuando corresponde y es seguro (consulte el Apéndice L, *Memorando de la reducción del carreteo/carreteo con un solo motor en el aeropuerto Logan*).
- Massport continúa mejorando el sistema de monitoreo del ruido y busca cotizaciones para un sistema mejorado.

Programa para la protección contra el sonido

- Massport cuenta uno de los programas de protección contra el sonido en viviendas y en escuelas más amplio del país. Al día de la fecha, Massport ha instalado protección contra el sonido en 5467 viviendas, incluidas 11 515 unidades de viviendas y 36 escuelas en East Boston, en Roxbury, en Dorchester, en Winthrop, en Revere, en Chelsea y en South Boston.
- Aproximadamente, el 8 por ciento de los solicitantes también eligieron la opción de Habitación de preferencia que permite que el propietario señale una habitación (generalmente un dormitorio o la sala de estar) para el tratamiento con acústica adicional.

21 Massport. 7 de octubre de 2016. *Massport y la FAA trabajan para reducir el ruido de los sobrevuelos (Massport and FAA Work to Reduce Overflight Noise)* https://www.massport.com/news-room/news/massport-and-faa-work-to-reduce-overflight-noise/.

Programa de sustentabilidad y resiliencia

Massport está comprometido con un sólido programa de sustentabilidad. La sustentabilidad ha redefinido los valores y los criterios para medir el éxito organizacional al usar un enfoque de resultado triple que toma en cuenta el bienestar económico, ecológico y social. Aplicar este enfoque a la toma de decisiones es una manera práctica de optimizar el capital económico, medioambiental y social. Massport tiene una amplia visión de la sustentabilidad que se basa en el concepto de resultado triple y toma en cuenta el contexto específico del aeropuerto. En congruencia con la definición de la sustentabilidad de los aeropuertos del Consejo Internacional de Aeropuertos - Norteamérica (Airports Council International - North America, ACI-NA),[22] Massport se centra en un enfoque holístico para el manejo del aeropuerto Logan para garantizar la viabilidad económica, la eficacia operativa, la conservación de los recursos naturales y la responsabilidad social (Economic viability, Operational efficiency, Natural resource conservation, and Social responsibility, EONS). Massport está comprometido con la implementación de prácticas sustentables para el medioambiente tanto por parte del aeropuerto como por parte de las autoridades y continúa progresando en diferentes iniciativas. Las siguientes secciones resumen muchas de las iniciativas de sustentabilidad a largo plazo y multifacéticas llevadas adelante por Massport, que se describen de manera más detallada en los capítulos individuales de este *ESPR 2017,* si corresponde. La **Figura 1-9** destaca algunas de las iniciativas de sustentabilidad recientes de Massport.

Plan de manejo para la sustentabilidad (Sustainability Management Plan, SMP) del aeropuerto Logan

En 2013, la FAA le otorgó a Massport un subsidio para preparar un SMP para el aeropuerto Logan. Las iniciativas de planificación del SMP del aeropuerto Logan comenzaron en mayo de 2013 y se completaron en abril de 2015. El SMP del aeropuerto Logan tiene una amplia perspectiva de sustentabilidad que incluye el estudio de la vitalidad económica, de la eficacia operativa, de la conservación de los recursos naturales y de la responsabilidad social. El SMP del aeropuerto Logan tiene como objetivo promover e integrar la sustentabilidad en todo el aeropuerto, y coordinar las iniciativas de sustentabilidad en curso en todo Massport. El SMP del aeropuerto Logan desarrolló un marco y un plan de implementación, con mediciones y objetivos diseñados para hacer un seguimiento del progreso en el tiempo.

Actualmente, Massport trabaja sobre la visión de “Sustentabilidad 2.0” de Massport como una próxima medida de planificación para implementar los principios y enfoques del SMP en otras instalaciones de Massport y para actualizar las metas y los objetivos de sustentabilidad. Actualmente, Massport está avanzando en una serie de iniciativas a corto plazo para ayudar a alcanzar sus objetivos (consulte la **Tabla 1-2**) en las áreas de (1) energía y emisiones de gases de efecto invernadero, (2) conservación del agua, (3) bienestar de la comunidad, de los empleados y de los pasajeros, (4) materiales, manejo de los desperdicios y reciclado, (5) resiliencia, (6) disminución del ruido, (7) mejora de la calidad del aire, (8) acceso terrestre y conectividad, (9) calidad del agua/desagües pluviales y (10) recursos naturales. Massport informa su progreso para alcanzar cada objetivo, incluidos los cambios en el desempeño

22 Consejo Internacional de Aeropuertos (ACI) Airport Sustainability: A Holistic Approach to Effective Airport Management. Sin fecha. http://www.aci-na.org/static/entransit/Sustainability%20White%20Paper.pdf.

relacionado, en los informes de sustentabilidad. Desde la publicación del SMP del aeropuerto Logan, Massport ha continuado expandiendo sus iniciativas de sustentabilidad, enfocándose cada vez más en la implementación de las medidas de resiliencia para proteger las operaciones marítimas y del aeropuerto Logan, la infraestructura crítica y la mano de obra.

El informe anual de sustentabilidad del aeropuerto Logan, publicado por primera vez en abril de 2016, brinda un resumen del progreso de las iniciativas de sustentabilidad en el aeropuerto Logan en función de los objetivos y de las metas de Massport establecidas en el SMP del aeropuerto Logan. Destaca el progreso de Massport hacia la mejora de la sustentabilidad y hacia la mejora de la resiliencia en sus instalaciones. Este informe, que ahora se denomina Informe anual de sustentabilidad y resiliencia, se actualizó en abril de 2018 para incluir las iniciativas de resiliencia y también se puede encontrar en: http://www.massport.com/massport/business/capital-improvements/sustainability/sustainability-management/.

Figura 1-9 Aspectos destacados de sustentabilidad recientes

- ✓ Cinco instalaciones certificadas por Leadership in Energy and Environmental Design (LEED) en el aeropuerto Logan
- ✓ Plan de gestión de la sustentabilidad e informe anual
- ✓ Pautas y estándares de diseño sustentable
- ✓ Cambio climático y planificación para la resiliencia: 60 % de los recursos críticos mejorados
- ✓ Paneles solares en el techo en Economy Garage, centro de alquiler de autos, Green Bus Depot, garage en la terminal B, terminal A y Logan Office Center
- ✓ Programa de vehículos con combustible alternativo (AFV): pasar las flotas de inquilinos o Massport a gas natural comprimido (GNC) o electricidad
- ✓ Pasar los equipos de servicio terrestre (GSE) de gas o diésel a versiones eléctricas
- ✓ Compromiso con los parques comunitarios y el espacio libre: más de 13,35 hectáreas de espacios verdes en East Boston
- ✓ Participación de interesados en la tarea de planificación “Sustentabilidad en Massport 2.0”

Tabla 1-2 Objetivos y descripciones de sustentabilidad del aeropuerto Logan

Categoría de sustentabilidad	Objetivo	Categoría de sustentabilidad	Objetivo
Energía y emisiones de gases de efecto invernadero (GHG)	Reducir la intensidad de la energía y las emisiones de GHG mientras se aumenta la parte de energía de Massport generada a través de fuentes renovables.	Preservación del agua	Preservar los recursos de agua regionales mediante la reducción del consumo de agua potable.
Bienestar de la comunidad, de los empleados y de los pasajeros	Promover comunidades económicamente prósperas, equitativas y sanas, y el bienestar de los pasajeros y de los empleados.	Materiales, manejo de los desperdicios y reciclado	Reducir la producción de desperdicios, aumentar la tasa de reciclado y utilizar materiales ecológicos.
Resiliencia	Transformarse en un modelo innovador y nacional para la planificación de resiliencia y para la implementación entre las autoridades portuarias.	Disminución del ruido	Minimizar los impactos del ruido de las operaciones de Massport.
Mejora de la calidad del aire	Disminuir las emisiones de los contaminantes del aire de las fuentes de Massport.	Acceso terrestre y conectividad	Proporcionar un acceso terrestre al aeropuerto Logan superior mediante medios de transporte alternativos y medios de transporte masivos (HOV).
Calidad del agua/Desagües pluviales	Proteger la calidad del agua y minimizar los desechos de contaminantes.	Recursos naturales	Proteger y restaurar los recursos naturales en las cercanías de Massport.

Instalaciones certificadas por Leadership in Energy and Environmental Design (LEED®) en el aeropuerto Logan

El sistema de calificación LEED de United States Green Building Counsil (USGBC) es el sistema de certificación de construcciones ecológicas de terceros más reconocido en los Estados Unidos. Massport se esfuerza por alcanzar la certificación LEED para todos los proyectos de construcción nuevos y de renovación sustancial sobre más de 1858 metros cuadrados. Más recientemente, en 2017, la nueva ala de aeronaves grandes de la terminal E (Proyecto de renovación y mejoras de la terminal E) recibió la certificación LEED dorada para los interiores comerciales. Otros ejemplos recientes de construcciones certificadas por LEED en el aeropuerto Logan son el RCC y Green Bus Depot (consulte **la Figura 1-10** y la **Tabla 1-3**). Hay más detalles disponibles en el capítulo 3, *Planificación del aeropuerto*.

Figura 1-10 Instalaciones certificadas por LEED en el aeropuerto Logan

Estándares de diseño sustentable y pautas, y certificación LEED

Para los proyectos de construcción más pequeños y para los proyectos que no son de construcción, Massport usa sus *Estándares de diseño sustentable y pautas (Sustainable Design Standards and Guidelines,* SDSG). Los SDSG brindan un marco para el diseño y para la construcción sustentables tanto para la construcción nueva como para los proyectos de rehabilitación. Los SDSG se aplican a una amplia variedad de criterios específicos del proyecto, como el diseño del sitio, los materiales del proyecto, el manejo de la energía, las emisiones atmosféricas, el manejo de la calidad del agua y la eficacia, la calidad del aire en el interior y la comodidad de los ocupantes. Massport también está evaluando la posibilidad de usar el sistema de calificación centrado en la sustentabilidad Parksmart del Consejo de Construcción Sustentable de los EE. UU. (US Green Building Council, USGBC), un sistema de calificación centrado en el medioambiente y en la sustentabilidad, específico para el manejo, la programación, el diseño y la tecnología de las estructuras de estacionamiento.

Tabla 1-3 Instalaciones certificadas por Leadership in Energy and Environmental Design (LEED) en el aeropuerto Logan

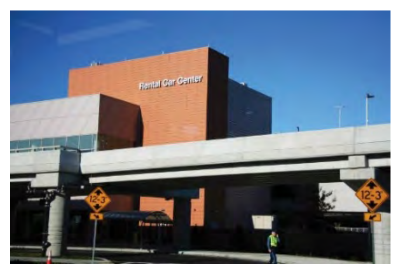
Terminal A (certificación LEED), completada en 2005/2006

- Primera terminal aeroportuaria en el mundo en recibir la certificación LEED
- Aceras con prioridad para medios de transporte masivos (HOV) y para bicicletas
- Modernización con paneles solares en el techo de la Terminal A
- Filtración de los desagües pluviales
- Techo reflectante
- Características de reducción del consumo de agua
- Iluminación diurna natural junto con tecnologías de iluminación avanzadas para la eficacia de la energía
- Uso de materiales reciclados y de fuentes regionales
- Medidas para mejorar la calidad del aire en el interior

Instalaciones de aviación general que respaldan los vuelos característicos (certificación LEED), completadas en 2007/2008

- Mecanismos para reducir el uso del agua
- Iluminación diurna natural con tecnologías de iluminación avanzadas para la eficacia de la energía
- Acristalamiento de las ventanas y sombrillas para maximizar la luz diurna y para minimizar el calentamiento
- Materiales reciclados y de fuentes regionales
- Medidas para mejorar la calidad del aire en el interior

Centro de alquiler de autos (RCC) (certificación LEED dorada) completado en 2013



- Materiales de construcción ecológicos
- Paneles solares en el techo
- Accesos y conexiones para bicicletas y peatones
- Iluminación diurna natural y tecnologías de iluminación avanzadas para la eficacia de la energía
- Uso de materiales reciclados y de fuentes regionales
- Calidad del aire en el interior mejorada
- Estaciones para enchufar vehículos eléctricos y otras fuentes de combustible alternativo como el E-85 (etanol)
- Flotas de autos de alquiler que incluyen vehículos híbridos/de combustible alternativo/de emisiones bajas
- Conexiones para peatones
- Instalaciones para bicicletas y duchas, vestuarios para empleados
- Recuperación del agua para el lavado de autos y uso de desagües pluviales para los usos no potables, como el lavado de vehículos y el riego.
- Reducción de las millas viajadas por vehículos (VMT)

Green Bus Depot (certificación LEED), completado en 2014

- Paneles solares en el techo
- Características de ahorro de agua y energía
- Reducción de VMT
- Nueva flota de transportes compartidos que incluyen 50 autobuses con diésel limpio/autobuses híbridos eléctricos y autobuses a gas natural comprimido (GNC).
- Materiales de construcción sembrados, cosechados, producidos y transportados de manera sustentable

Tabla 1-3 Instalaciones certificadas por Leadership in Energy and Environmental Design (LEED) en el aeropuerto Logan (cont.)

Nueva ala para aeronaves grandes en la Terminal E (certificación LEED dorada para interiores comerciales) completada en 2017

- Reducción del efecto isla de calor al proporcionar un techo blanco reflectante y asfalto de concreto de color claro
- Instalaciones para el agua y para retretes de flujo bajo
- Instalaciones para la luz eficientes, y calefacción, ventilación y sistema de aire acondicionado (heating, ventilation, and air conditioning, HVAC) eficientes
- Uso de fuentes de energía renovables
- Materiales reciclados y de fuentes regionales
- Calidad del aire en el interior mejorada
- Sistema de agua caliente solar térmico para agua de uso doméstico para calentar el 100 por ciento del agua de uso doméstico del ala

Cambio climático y planificación para la resiliencia

Ya que el área de Boston continuará experimentando temperaturas elevadas, condiciones climáticas extremas más frecuentes y nivel del mar más elevado debido al cambio climático,[23] Massport entiende la importancia de prepararse para los impactos para proteger y mejorar su infraestructura, sus activos operativos y su mano de obra críticos. Mediante la sólida planificación y la colaboración regional, Massport se esfuerza por continuar su función de liderazgo en la planificación de la resiliencia entre las autoridades portuarias, la industria aeroportuaria y la región de Boston.

A finales de 2013, Massport comenzó un estudio para la planificación para desastres y resiliencia de la infraestructura (Disaster and Infrastructure Resiliency Planning, DIRP) para el aeropuerto Logan, para el puerto de Boston, y para los recursos marítimos de Massport en el sur y Este de Boston. El estudio de DIRP incluye el análisis de los peligros, el modelado del aumento del nivel del mar y marejada ciclónica, y proyecciones de temperatura, precipitaciones y aumentos anticipados de fenómenos meteorológicos extremos. El estudio de DIRP brinda recomendaciones sobre las estrategias a corto plazo para hacer que las instalaciones de Massport sean más resilientes a los posibles efectos del cambio climático. En 2014, el estudio se completó y se comenzó la implementación de las iniciativas de adaptación a finales de 2014.

Además del estudio de DIRP y de sus iniciativas relacionadas, Massport completó una evaluación de los riesgos con todas las autoridades de sus iniciativas de planificación estratégica, emitió una guía de diseño a prueba de inundaciones (Floodproofing Design Guide) y desarrolló un marco de resiliencia para brindar mediciones congruentes para la planificación a corto y a largo plazo, y para la protección de sus instalaciones e infraestructura críticas. Más allá de la resiliencia física, Massport también se centra en la incorporación de resiliencia social y económica en su planificación operativa y de capital a largo plazo. La

23 Ciudad de Boston. 2016. *Climate Ready Boston*. https://www.boston.gov/sites/default/files/climatereadyeastbostoncharlestown_finalreport_web.pdf.

Guía de diseño a prueba de inundaciones de Massport se publicó en noviembre de 2014 y se actualizó en abril de 2016.

Los aspectos operativos de la estrategia de resiliencia incluyen el desarrollo de planes para el manejo de inundaciones para el aeropuerto Logan y para las instalaciones marítimas de Massport. Estos planes se introdujeron en 2015 e incluyeron los despliegues previstos para las barreras temporarias contra inundaciones para proteger hasta 12 ubicaciones de infraestructura crítica en caso de condiciones climáticas extremas. Se mejoraron de manera permanente ubicaciones adicionales para prevenir inundaciones. Los planes operativos para inundaciones se evalúan anualmente para mejorar su eficacia y para que se adapten a los requisitos cambiantes y en función de experiencias pasadas.

Se realizaron ejercicios de simulación de un huracán y talleres multifuncionales para refinar más los planes y para entrenar al personal. Por último, el nivel de inundación del diseño originado por el estudio de DIRP en 2015 se actualizó como resultado del modelado de tormentas mejorado que MassDOT puso a disposición de Massport. Se realizaron ajustes a las recomendaciones de resiliencia prioritarias para adaptarlos al nivel de inundación revisado.

Massport informa el progreso hacia los objetivos de resiliencia en los informes de sustentabilidad anuales del aeropuerto Logan. Se encuentra disponible información adicional sobre las iniciativas de resiliencia de Massport en el siguiente enlace:http://www.massport.com/massport/business/capital-improvements/sustainability/climate-change-adaptation-and-resiliency/resiliency-and-climate-change/.

Sociedades de Massport y respaldo a la comunidad

Massport tiene un compromiso que data de hace tiempo de ser un buen vecino. Al trabajar en colaboración con el gobierno, con la comunidad y con los líderes civiles en todo Massachusetts y Nueva Inglaterra, Massport participa activamente realizando esfuerzos para mejorar la calidad de vida de las personas que residen cerca de las instalaciones de Massport. Los empleados de Massport participan en numerosas actividades comunitarias. Durante la primavera, los empleados de Massport participan en la limpieza anual del vecindario Boston brilla (Boston Shines) de la ciudad de Boston. Durante la época de Acción de gracias, los empleados de Massport donan alimentos a tres programas comunitarios, que atienden a más de 500 familias y personas todos los meses. Durante el otoño, a los niños de entre cuatro y 17 años se les entrega una mochila nueva llena de artículos escolares y ropa nueva para empezar el año escolar. Durante las vacaciones, Massport invita a los estudiantes de las comunidades vecinas y de las escuelas primarias a cantar en la Terminal A, como parte del programa anual de música de vacaciones.

En 2016, Massport brindó apoyo financiero a más de 60 organizaciones comunitarias, entre ellas: Boys & Girls Clubs, Codman Square and South Boston Health Centers y numerosas organizaciones juveniles y recreativas. En abril de 2017, Massport organizó la exposición anual de educación en ciencia, tecnología, ingeniería y matemática (Science, Technology, Engineering, and Mathematics, STEM) de aviación y marítima en el aeropuerto Logan para más de 1700 estudiantes de la mayoría de las 40 escuelas de Greater Boston. Massport también ofrece numerosas oportunidades de becas para quienes se gradúan en el último año de la escuela superior. Además, Massport y jetBlue organizan la apertura de “Empujar por la

esperanza" (Pulling for Hope) de la Sociedad Americana contra el Cáncer en la que personas empujan un avión de 45 360 kg en el aeropuerto Logan para recaudar dinero para la investigación del cáncer.

Para ver un listado completo de las iniciativas de colaboración de Massport, visite: http://www.massport.com/massport/community/community-partners/.

East Boston Foundation. East Boston Foundation fue creada por Massport en 1997 a pedido de la comunidad y ha brindado cerca de USD 10 millones en apoyo financiero para 85 programas comunitarios que benefician a niños, a adultos y a personas mayores, en áreas que van desde deporte y recreación hasta educación, entrenamiento y atención para niños. El consejo directivo de East Boston Foundation está comprometido con la administración financiera, el reconocimiento de las necesidades cambiantes de la comunidad y con la mejora de la calidad de vida de los residentes de East Boston.

Massport Means Business. Massport está tomando medidas para crear más oportunidades de negocio en el aeropuerto Logan para las empresas de East Boston. En 2016, Massport, la Cámara de comercio del East Boston e East Boston Main Streets copatrocinaron- la iniciativa *MASSPORT ES NEGOCIO* para conocer más sobre cómo es hacer negocios en Massport. La misión de Massport es garantizar que los negocios de East Boston tengan todas las oportunidades de prosperar al asociarse con nosotros para atender las necesidades de nuestros pasajeros y aerolíneas, y las necesidades de seguridad y mantenimiento.

Programa de espacio abierto/amortiguación. Massport ha invertido en un amplio programa de espacio abierto para mejorar las comunidades circundantes. Massport destinó inicialmente más de USD 15 millones para la planificación, la construcción y el mantenimiento de cuatro espacios abiertos y dos parques junto al perímetro del aeropuerto Logan. Estos amortiguadores incluyen Bayswater Buffer, Navy Fuel Pier Buffer y SWSA Buffer (etapas I y II). El premiado Piers Park se completó en 1995 y desde entonces se ha convertido en parte de una red de espacios verdes que atraviesa East Boston desde la zona costera Jeffries Point hasta Constitution Beach.

La etapa II de Piers Park, contigua al actual Piers Park, sumará 1,7 hectáreas de espacio verde a la zona costera de East Boston una vez completada y hay planes de un tercero para la etapa III de Piers Park, que transformarán un viejo muelle en un espacio verde de 1,45 hectáreas, el que incluirá características de resiliencia para ayudar a proteger el vecindario de la inundación y del aumento del nivel del mar. Hoy, East Boston disfruta de 5,3 km y de más de 13,3 hectáreas de espacio verde desarrollado o manejado por Massport, en colaboración con la comunidad de East Boston y en respuesta a su participación. Puede obtener más información en el Capítulo 3, *Planificación aeroportuaria*.

Figura 1-11 Parques de propiedad de Massport y operados por este y la ciudad de Boston

Fuente: VHB.

Puntos destacados y hallazgos clave de 2017 y horizonte de planeación futura

Esta sección brinda un breve resumen de los hallazgos clave, por capítulo, en el aeropuerto Logan en 2017 y el horizonte de planeación futura. Se ofrece información adicional sobre las actividades del aeropuerto en los capítulos subsiguientes. Esta sección también destacará las iniciativas de Massport para una mayor sustentabilidad a través de proyectos específicos e iniciativas con una hoja de sustentabilidad y resume el programa de sustentabilidad de Massport.

Niveles de actividad

El aeropuerto Logan (y la industria de la aviación en general) ha estado experimentando un fuerte crecimiento, en gran parte por las condiciones económicas positivas en la región de Boston, el bajo desempleo, una base económica diversa y fuerte, y la inversión continua en bienes raíces comerciales y residenciales, en ciencias biológicas en particular, en las finanzas, en la atención médica y en la educación superior. La expansión de las rutas internacionales atendidas por el aeropuerto Logan respalda las oportunidades económicas que tienen los residentes de Massachusetts al permitirles alcanzar decenas de mercados en todo el mundo y de mejorar la competitividad ya que es una ubicación de primer nivel global para los negocios, la investigación, la educación, la tecnología y el turismo.[24]

En 2017, los niveles de actividad de pasajeros en el aeropuerto Logan alcanzaron 38,4 millones en todo momento, un aumento del 5,9 por ciento en comparación con 2016. Las operaciones de las aeronaves aumentaron de forma más paulatina, alcanzando un total de 401.371 en 2017, un aumento del 2,6 por

24 *Mass*Benchmarks. 2018. *The Journal of the Massachusetts Economy, Volume 20 Issue 2.*

ciento en comparación con los niveles de 2016. Esta tendencia continuó en 2018, y los niveles de actividad de los pasajeros alcanzaron un total de 40,9 millones y las operaciones de las aeronaves fueron de 424.024. El crecimiento está directamente correlacionado con la fuerte economía nacional y regional. Las operaciones de las aeronaves permanecen muy por debajo de las 487.996 operaciones de 2000 y del pico histórico de 507.449 operaciones alcanzadas en 1998.

De 2010 a 2017, la cantidad anual de pasajeros en el aeropuerto Logan aumentó alrededor de un 40 por ciento, mientras que la cantidad anual de operaciones[25] aumentó más lentamente, alrededor del 14 por ciento, debido al aumento de los factores de carga de las aeronaves. Los niveles de pasajeros internacionales aumentaron más rápidamente que los niveles de pasajeros con destinos nacionales en 2017. Los niveles de actividad de los pasajeros aéreos con destinos domésticos aumentaron un 5,1 por ciento mientras que los niveles de actividad de los pasajeros aéreos internacionales aumentaron un 9,3 por ciento en comparación con los niveles de 2016.

Como parte de sus medidas de planificación estratégica en curso, Massport confecciona proyecciones de las operaciones de las aeronaves y de los niveles de actividad de los pasajeros cada unos pocos años. Este *ESPR de 2017* evalúa las condiciones medioambientales y de las operaciones futuras asociadas con una proyección de 50 millones de pasajeros aéreos anuales en los próximos 10 a 15 años (el horizonte de planificación futura). Según las proyecciones, este nivel de pasajeros aéreos será atendido en aproximadamente 486.000 operaciones de aeronaves anuales. Las proyecciones de Massport son congruentes con la Proyección del área de las terminales de la FAA. En el plazo del horizonte de planeación de 10 a 15 años, la proyección de la FAA es de 50 millones de pasajeros aéreos anuales.

Consulte el Capítulo 2, *Niveles de actividad,* para obtener información adicional.

Planificación aeroportuaria

Massport continuamente mejora las instalaciones del aeropuerto Logan para adaptarlo a los cambios de la demanda de pasajeros, de la actividad de las aeronaves, de las necesidades de las cargas y del acceso al transporte. En el Capítulo 3, *Planificación aeroportuaria*, Massport ha identificado proyectos de planificación prioritarios e iniciativas para atender a la mayor demanda de viajes internacionales y nacionales, incluidos los proyectos y las iniciativas de las siguientes categorías:

- Transporte terrestre y estacionamiento.
- Terminales.
- Planificación de la zona de operaciones.
- Áreas de servicio.
- Amortiguadores del aeropuerto y espacio abierto
- Energía, sustentabilidad y resiliencia

25 Una operación de una aeronave se define como un arribo o una partida.

Actualmente, Massport se enfoca en mejorar la experiencia de los pasajeros y de los usuarios del aeropuerto Logan tanto dentro del aeropuerto como mejorando el acceso desde y hacia este patrimonio regional. Los proyectos del área de la terminal recientes y en curso brindan una conectividad posterior a la seguridad sin inconvenientes entre las terminales y mejoras al sistema de proceso de pasajeros a través de las áreas de verificación de seguridad consolidadas.

Para aliviar la congestión en las carreteras dentro del aeropuerto y la accesibilidad, Massport tiene planeado implementar grandes proyectos de conectividad en las carreteras dentro del aeropuerto y en la línea Blue de la MBTA/entre las terminales, y tiene planeado construir áreas consolidadas para recoger/dejar pasajeros para las TNC. Massport también planea expandir los servicios de HOV y las instalaciones de Logan Express como parte de un programa de mejoras relacionadas con el transporte terrestre.

Desde que se presentó el *EDR de 2016,* Massport ha presentado dos proyectos para que la MEPA los revise:

- El proyecto de modernización de la Terminal E, en el que se ha aprobado la inclusión de siete puertas de embarque nuevas a la terminal internacional.
- El Proyecto de estacionamiento del aeropuerto Logan, que añadirá 5000 espacios de estacionamiento comercial en el aeropuerto Logan en ubicaciones que ya se usan para el estacionamiento. Se pueden permitir espacios de estacionamiento adicionales, en función de una modificación al Congelamiento del Estacionamiento del Aeropuerto Logan,[26] para reducir las modalidades para recoger/dejar pasajeros perjudiciales para el medioambiente (es decir, recoger o dejar pasajeros en vehículos privados, en taxi, en TNC o mediante servicios de limusinas con chofer. Actualmente, este proyecto está siendo revisado conjuntamente por la MEPA y la NEPA.

Massport continúa trabajando con la FAA para mejorar la seguridad en la zona de operaciones a través de una variedad de proyectos de RSA y de simplificación en la geometría del campo de aviación. Consulte el Capítulo 3, *Planeación aeroportuaria,* para obtener más información.

Transporte regional

En 2017, se observó un aumento en la actividad de pasajeros en la región de Nueva Inglaterra. Los pasajeros aéreos de la región aumentaron en un 5,5 por ciento y alcanzaron 54,7 millones de pasajeros aéreos en 2017, un pico histórico. Los 10 aeropuertos regionales (sin incluir el aeropuerto Logan) de Nueva Inglaterra atendieron a 16,3 millones de pasajeros aéreos en 2017, en comparación con 15,6 millones de pasajeros en 2016.

En Worcester Regional Airport, Bradley International Airport, T.F. Green Airport, Portland International Jetport y Burlington International Airport se observó un aumento general en los servicios ofrecidos en 2017. En los aeropuertos Manchester-Boston Regional y Tweed-New Haven se observó una disminución de los servicios ofrecidos en 2017. Los tres aeropuertos de Massport, Logan Airport, Worcester Regional

26 Título 310, sección 7.30 del Código de Normas de Massachusetts, y título 40, sección 52.1120 del Código de Reglamentaciones Federales

Airport y Hanscom Field contribuyeron de manera significativa con la economía regional, generando aproximadamente USD 23,1 mil millones anualmente o el 94 por ciento de los beneficios de la economía general generados por el sistema de aeropuertos de Massachusetts. Hanscom Field es un aeropuerto de relevo del aeropuerto Logan y es el segundo aeropuerto con mayor actividad en Nueva Inglaterra.

Aeronave E-190 de jetBlue en Worcester Regional Airport.

Fuente: Massport.

En Worcester Regional Airport se observó un aumento en la cantidad de pasajeros de un 32 por ciento en 2018 en comparación con 2017, y se informó un total de aproximadamente 600.000 pasajeros desde 2013 hasta 2018. En los últimos cinco años, Worcester Regional Airport ha experimentado una tasa de crecimiento promedio del 30 por ciento por año. Massport continúa invirtiendo en Worcester Regional Airport. Junto con la ciudad de Worcester, Massport ya ha comenzado una inversión de USD 100 millones a 10 años para revitalizar y atraer operaciones comerciales en Worcester Regional Airport. Las inversiones incluyen un sistema de aterrizaje instrumental CAT III (alrededor de USD 32 millones) que se pagan con subvención federal y fondos de Massport. Además, jetBlue Airways, American Airlines y Delta Air Lines anunciaron un nuevo servicio al JFK, al Philadelphia International Airport y al Detroit Metropolitan Wayne County Airport, respectivamente.

Los viajes de todo el sistema de trenes Amtrak permaneció estable con 31,7 millones de viajes de usuarios desde el año fiscal (fiscal year, FY) 2017 hasta el FY 2018. El corredor noreste (Northeast Corridor, NEC) transportó más de 12 millones de pasajeros, alrededor de un 1 por ciento más que el año anterior. A mediados de 2018, Amtrak anunció inversiones de USD 370 millones en nuevos equipos para instalar una capacidad de mantenimiento de la infraestructura de dos vías en el NEC en los siguientes tres años, junto con trenes Acela Express de próxima generación que aumentarán la capacidad de asientos por tren en un 27 por ciento.[27]

Acceso terrestre desde y hacia el aeropuerto Logan

Massport cuenta con una estrategia integral múltiple de reducción de viajes para diversificar y mejorar las opciones de transporte terrestre para los pasajeros y para los empleados que viajan desde y hacia el aeropuerto Logan. La estrategia de transporte terrestre está diseñada para ofrecer a los pasajeros que viajan desde y hacia el aeropuerto Logan la oportunidad de elegir entre HOV, transporte público y opciones de viajes compartidos que son prácticas y confiables, y que reducen los impactos medioambientales y en la comunidad. El aeropuerto Logan continúa siendo uno de los principales aeropuertos de los EE. UU. en cuanto a la modalidad de HOV y de viajes en transporte público. Massport promueve numerosas opciones de HOV, transporte público y viajes compartidos para mejorar las

27 Amtrak. 2018. *Perfil de la compañía en el FY 18*. http://media.amtrak.com/wp-content/uploads/2019/03/Amtrak-Corporate-Profile_FY2018_Pub-March-1-2019.pdf.

carreteras dentro del aeropuerto y las operaciones en las aceras, para aliviar las limitaciones de estacionamiento y para mejorar el servicio al cliente. Las iniciativas clave incluyen las siguientes:

- El objetivo de duplicar los viajes en Logan Express al expandir el estacionamiento, la frecuencia y a través de mejoras en las instalaciones.
- El plan de adquirir ocho autobuses más de la línea Silver de la MBTA, lo que aumentará el tamaño de la flota adquirida por Massport a 16 autobuses.
- Implementar un plan de manejo de una TNC (como Uber y Lyft) para reducir la congestión dentro el aeropuerto, incluido el foco en el flujo constante de pasajeros y en los viajes compartidos.

La estrategia de Massport también tiene como objetivo brindar suficiente estacionamiento dentro del aeropuerto para los pasajeros aéreos que eligen la modalidad de acceso en automóvil y/o que tienen opciones de HOV limitadas. En 2017, el Departamento de Protección Medioambiental de Massachusetts (MassDEP) enmendó el Congelamiento del Estacionamiento en el Aeropuerto Logan para permitir un aumento de hasta 5000 espacios de estacionamiento comercial dentro del aeropuerto, lo que permite la construcción de estacionamientos adicionales para reducir las modalidades para recoger/dejar pasajeros y para aliviar las condiciones de estacionamiento limitado dentro del aeropuerto.

Autobús Framingham Logan Express
Fuente: Alan Dines

Los hallazgos clave se resumen en las viñetas a continuación y se pueden encontrar detalles adicionales en el Capítulo 5, *Acceso terrestre desde y hacia el aeropuerto Logan.*

- Las VMT promedio dentro del aeropuerto en los días de semana aumentaron alrededor de un 11 por ciento, de aproximadamente 176.840 en 2016 a 196.500 en 2017. El cambio en el tráfico diario promedio se puede atribuir principalmente a los aumentos en la actividad de los pasajeros, a la actividad de recoger/dejar pasajeros, a la carga y a los usos no relacionados con la aviación del aeropuerto.
- En 2017, Massport comenzó el seguimiento y el informe de la actividad de las TNC. Se calculó que las TNC contribuyen con alrededor de 15 000 viajes de vehículos por día (sin incluir los viajes de un solo tramo[28]). Las TNC tienen un impacto en otras modalidades de acceso al aeropuerto y contribuyen a la congestión dentro del aeropuerto. Parcialmente debido a la aparición de las TNC, los viajes en limusinas con chofer y los viajes programados en van disminuyeron un 40 por ciento de 2016 a 2017. Los servicios de los taxis disminuyeron un 18 por ciento y los viajes en la línea Blue de la MBTA disminuyeron un 2 por ciento en 2017 en comparación con 2016.

28 Los viajes de un solo tramo son aquellos viajes desde el aeropuerto que no llevan ningún pasajero.

- En función de cambios constantes en las elecciones de la modalidad de los pasajeros para acceder al aeropuerto Logan, Massport ha actualizado sus objetivos y su definición de HOV. La definición actualizada considera que los taxis, las limusinas con chofer y las TNC que llevan a más de un pasajero aéreo por vehículo son HOV, mientras que las mismas modalidades con un pasajero aéreo no contarán como HOV. Con esta definición actualizada, Massport se comprometió a llegar a un objetivo del 35,5 por ciento de HOV para 2022 y del 40 por ciento para 2027.
- Cuando los niveles de actividad alcancen 50 millones de pasajeros aéreos, se prevé que regirán los cambios en las políticas de transporte de Massport y las posibles modificaciones a la infraestructura que reducen las VMT dentro del aeropuerto. Las modificaciones a la infraestructura podrían incluir carriles especiales dentro del aeropuerto para los autobuses de HOV, la creación de un centro de transporte de diferentes modalidades con servicio de autobuses a las terminales, la posible construcción de un APM o alguna combinación de estas mejoras.

Disminución del ruido

Massport se esfuerza por minimizar los efectos del ruido de las operaciones del aeropuerto Logan en sus vecinos mediante diferentes programas, procedimientos, estudios y demás herramientas para la disminución del ruido. En el aeropuerto Logan, Massport implementa uno de los programas para la disminución del ruido más antiguos y amplios de cualquier aeropuerto del país. El programa integral de disminución del ruido incluye una Oficina para la Disminución del Ruido especializada, un sistema de monitoreo del ruido y de operaciones (Noise and Operations Monitoring System, NOMS) de avanzada, programas de protección contra el sonido para casas y escuelas, restricciones de horarios y de pistas para los aviones más ruidosos, procedimientos de prueba de motores en tierra y seguimiento de vuelos diseñado para optimizar las operaciones sobre el agua (especialmente durante las horas de la noche). La población puede dejar asentadas quejas por ruido por teléfono o en línea a través del sitio web de Massport.[29]

Los hallazgos clave se resumen en las viñetas a continuación y se pueden encontrar detalles adicionales en el Capítulo 6, *Disminución del ruido*.

Imagen de un dispositivo generador de vórtices por puerto en el ala.

- Massport alienta la modernización de la familia de aerobuses A319/320/321 con generadores en vórtice, lo que reduce el ruido tonal al acercarse. United Airlines anunció la modernización de sus aeronaves en 2017 cuando ingresaron para que se les realicen servicios. En un comunicado de prensa en octubre de 2018, jetBlue Airways (la aerolínea con mayor cantidad de operaciones en el aeropuerto Logan) anunció planes para modernizar su flota de aerobuses más antigua con generadores de vórtices.
- La mezcla de flota de aeronaves en el aeropuerto Logan sigue estando compuesta por tipos de aeronaves con la tecnología más silenciosa disponible; la Fase 5 es la más silenciosa.

29 Massport. Quejas por ruidos. http://www.massport.com/logan-airport/about-logan/noise-abatement/complaints/.

Aproximadamente, el 18 por ciento de las operaciones de 2017 se realizaron con aeronaves que cumplen los requerimientos de la Fase 5, el 80 por ciento con aeronaves que cumplen los requerimientos de la Fase 4 y el 2 por ciento con aeronaves con certificación de Fase 3. En el horizonte de planeación futura, la flota estará compuesta aproximadamente por un 56 por ciento de aeronaves de Fase 5, un 43 por ciento de aeronaves de Fase 4 y un 2 por ciento de aeronaves de Fase 3. Se prevé que la modernización prevista de la mezcla de la flota y la proyección de la división entre el día y la noche moderen los efectos del aumento de la proyección en las operaciones de las aeronaves.

- Massport y la FAA están trabajando con el MIT para investigar las oportunidades para reducir el ruido mediante cambios en la PBN, incluida la RNAV. Esta colaboración es el primer programa en el país entre la FAA y un operador aeroportuario para entender mejor lo que implica la PBN y para evaluar las estrategias para abordar las preocupaciones de la comunidad.
- Massport sigue siendo un líder nacional en mitigación de la aislación sonora. Al día de la fecha, Massport proporcionó aislación sonora para un total de 36 escuelas y 11 515 unidades residenciales, y continuará buscando financiamiento para la aislación sonora de propiedades que son elegibles y cuyos propietarios eligieron participar.
- Las operaciones nocturnas representan el 15 por ciento del total de las operaciones para el aeropuerto Logan en 2017. Las operaciones nocturnas aumentaron, de un promedio de 152 por noche en 2016 a 168 en 2017. La mayoría (82 por ciento) de las operaciones nocturnas se produjeron antes de la medianoche o después de las 5:00 a. m.
- La curva de nivel de sonido promedio durante el día/la noche (Day-Night Average Sound Level, DNL) de 2017 es similar en forma y en tamaño a la de 2016, con pequeños aumentos en general. La cantidad de personas que residen dentro de la curva de DNL de 65 decibeles (dB) aumentó de 7450 en 2016 a 7933 en 2017, un aumento de 483 personas. La población adicional dentro de la curva de DNL de 65 dB se ubica principalmente en Chelsea y en el área de East Boston entre los extremos de la pista 15R y de la pista 22R. Este aumento se debe principalmente al aumento de las salidas en la pista 33L. Los cambios en el uso de la pista, debidos principalmente al cierre de la pista 4R, y un aumento en las operaciones nocturnas también contribuyeron a los cambios en la cantidad de personas expuestas a los valores de DNL mayores o iguales a 65 dB en 2017.
- En el horizonte de planeación futura, la curva de DNL de 65 dB se expande en determinadas áreas debido al crecimiento previsto en la cantidad de operaciones. La cantidad de personas que residen dentro de la curva de DNL de 65 dB se prevé que aumentará de 7933 en 2017 a 8356 en el futuro, un aumento de 423 personas, todas dentro de las áreas que Massport ya ha protegido contra el sonido o que fueron elegibles para la protección contra el sonido en el pasado.
- En comparación con 1990, la cantidad total de personas que residen en la curva de DNL de 65 dB es aproximadamente un 82 por ciento más baja y un 81 por ciento más baja en 2017 y en el horizonte de planeación futura, respectivamente, debido a una mejora en la tecnología de los motores.

Calidad del aire/Reducción de emisiones

La estrategia para el manejo de la calidad del aire para el aeropuerto Logan se centra en la disminución de las emisiones de las fuentes relacionadas con el aeropuerto. Debido a que Massport no tiene un control directo sobre las operaciones de las aeronaves ni de las elecciones de las flotas de las aerolíneas,

continúa enfocándose en las áreas que Massport sí controla o sobre las que tiene posibilidades de influenciar. Las iniciativas clave de Massport para reducir las emisiones atmosféricas de las operaciones del aeropuerto incluyen las siguientes:

- Reemplazo del GSE que funciona con gasolina y con diésel por equivalentes eléctricos para finales de 2027, si están disponibles comercialmente.
- Compromiso con LEED® y con otros estándares de construcción sustentable.
- Inversiones en instalaciones de energía renovable dentro del aeropuerto (solar/eólica).
- Uso de autobuses de enlace que utilizan combustible limpio.
- Implementación de amplias estrategias para fomentar el uso de HOV y para mejorar el transporte terrestre.

Massport confeccionó listados de emisiones para 2017 para los criterios de los siguientes contaminantes: monóxido de carbono (CO), partículas ($PM_{10}/PM_{2,5}$) y compuestos orgánicos volátiles (VOC), así como GHG y óxidos de nitrógeno (NO_x). Massport también confeccionó listados de emisiones para el horizonte de planeación futura. Los hallazgos clave de estos listados de emisiones incluyen los siguientes:

- Las emisiones de CO, $PM_{10}/PM_{2,5}$ y VOC totales modelizadas disminuyeron de 2016 a 2017, alrededor del 4 por ciento, del 20 por ciento y menos del 1 por ciento, respectivamente, aunque las operaciones de las aeronaves aumentaron en el mismo periodo. En el futuro, se prevé que las emisiones totales de CO, $PM_{10}/PM_{2,5}$ y VOC disminuyan más, alrededor del 2 por ciento, del 10 por ciento y del 8 por ciento, respectivamente, en comparación con los niveles de 2017. La proyección de la reducción de las emisiones se debe a una combinación de la conversión del GSE a alternativas eléctricas viables, a menos emisiones de vehículos a motor debido a una mejor eficiencia, a tecnologías de motores de aeronaves más limpios y a cambios en la mezcla de la flota de las aeronaves.
- Las emisiones totales de NO_x aumentaron alrededor del 12 por ciento de 2016 a 2017. Este aumento en el NO_x se atribuye casi por completo al cambio en la flota de las aeronaves (es decir, mayor uso de motores de aeronaves más silenciosos, que utilizan menos combustible, lo que deriva en menores emisiones con la excepción del NO_x) junto con el aumento proyectado de las operaciones de las aeronaves del aeropuerto. Se prevé que las emisiones de NO_x aumenten alrededor de un 37 por ciento en el horizonte de planeación futura en comparación con 2017. Los cambios también se atribuyen al modelo de la Herramienta de Diseño Medioambiental para la Aviación (Aviation Environmental Design Tool, AEDT) de la FAA, que asume mayores factores de NO_x en comparación con el sistema de modelado de emisiones y dispersión (Emissions and Dispersion Modeling System, EDMS) preexistente. Las emisiones de NO_x asociadas con el GSE, con los vehículos con motor y con las fuentes estacionarias, muchas de las cuales controla Massport o sobre las que tiene influencia, han disminuido.
- Las emisiones de GHG aumentaron alrededor de un 8 por ciento de 2016 a 2017 debido al aumento de las operaciones de las aeronaves. Sin embargo, las emisiones de GHG totales del aeropuerto Logan se mantuvieron en menos del 1 por ciento de las emisiones de todo el estado en 2017. Se prevé que el total de las emisiones de GHG en el horizonte de planeación futura serán de alrededor del 23 por ciento más que los niveles de 2017, lo que se debe, predominantemente, al aumento de las operaciones de las aeronaves.

Consulte el Capítulo 7, *Calidad del aire/Reducción de las emisiones*, para obtener información adicional.

Calidad del agua/Cumplimiento y manejo medioambiental

El enfoque de Massport en cuanto al manejo medioambiental y al cumplimiento es un componente clave de su compromiso con la sustentabilidad y con las prácticas responsables en el aeropuerto Logan. Mediante el monitoreo y la documentación, Massport evalúa el desempeño medioambiental, y desarrolla, implementa, evalúa y mejora las políticas y los programas continuamente. Massport promueve las prácticas medioambientales apropiadas a través de la prevención de la contaminación y de las medidas de reparación. Massport también trabaja estrechamente con los locatarios y con el personal de operaciones del aeropuerto Logan para intentar mejorar continuamente el cumplimiento medioambiental. Los hallazgos clave de este ESPR incluyen los siguientes:

- En 2017, el 100 por ciento de las muestras de aguas pluviales cumplieron con los requisitos del permiso del Sistema Nacional de Eliminación de Descarga de Contaminantes (National Pollutant Discharge Elimination System, NPDES)
- Massport cuenta con su Sistema de Manejo Medioambiental (Environmental Management System, EMS) de la Organización Internacional de Normalización (ISO) 14001 desde 2006.
- Massport actualiza y mantiene periódicamente su Plan de Prevención de la Contaminación del Agua Pluvial (Stormwater Pollution Prevention Plan, SWPPP) para el aeropuerto Logan.
- Massport continúa evaluando, remediando y consiguiendo la clausura reglamentaria de las áreas con contaminación subsuperficial.
- Ocho derrames requirieron informe en 2017, lo que representó una disminución de los derrames informados en 2016 (14 total). La cantidad de derrames que ingresaron en un sistema de drenaje también disminuyeron, de cinco en 2016 a dos en 2017.

Para obtener información adicional, consulte el Capítulo 8, *Cumplimiento y manejo medioambiental/Calidad del agua*.

Proceso de revisión medioambiental del aeropuerto Logan

Este *ESPR de 2017* es parte de un proceso de revisión estatal formal, bien consolidado, que evalúa los impactos medioambientales acumulados del aeropuerto Logan. El proceso brinda un contexto frente al cual los proyectos individuales que alcanzan umbrales de revisión medioambiental estatales y federales se evalúan sobre las bases de proyectos específicos. A continuación, se describen los procesos de revisión medioambiental específicos del proyecto para todo el aeropuerto.

Contexto histórico para el EDR/ESPR del aeropuerto Logan

En 1979, la secretaría de la EEA emitió un certificado solicitando a Massport que defina, evalúe y divulgue cada tres años el impacto del crecimiento a largo plazo del aeropuerto a través de un Informe de impactos medioambientales genérico (Generic Environmental Impact Report, GEIR). En el certificado también se solicitó actualizaciones anuales provisorias para brindar datos sobre las condiciones para los años entre los GEIR. El GEIR evolucionó hasta transformarse en una herramienta de planificación eficaz

para Massport y brindó proyecciones de condiciones medioambientales para que los efectos acumulados de los proyectos individuales se puedan evaluar dentro de un contexto más amplio.

La EEA eliminó los GEIR después de las revisiones de 1998 para sus reglamentaciones de la MEPA. Sin embargo, la certificación del secretario sobre la actualización anual de 1997[30] propuso un proceso de análisis medioambiental revisado para el aeropuerto Logan lo que dio como resultado la confección de los EDR/ESPR de Massport subsiguientes. El EPRS más amplio brinda un análisis de largo alcance de las operaciones, de los pasajeros y de los impactos acumulados proyectados, mientras que los EDR se confeccionan anualmente para brindar una revisión de las condiciones medioambientales para el año que se informa en comparación con el año anterior. Se desarrolló el proceso del EDR/ESPR para permitir que se analicen los proyectos individuales en el aeropuerto Logan en un contexto más amplio en todo el aeropuerto. Como se estableció en la introducción del *ESPR de 1999,* mientras que el ESPR y el EDR de Logan brindan el contexto amplio de la planificación para los proyectos propuestos para el aeropuerto Logan y los conceptos de planificación futuros que Massport analiza, no se puede crear ningún proyecto sólido en las bases de inclusión y análisis en el *ESPR de 1999*. Luego establece que los proyectos que cumplen con los umbrales de revisión de la MEPA o NEPA deben someterse a estos procesos, si es necesario. En resumen, los EDR/ESPR brindan un contexto de planificación acumulada que complementa las presentaciones individuales específicas del proyecto.

En los últimos años, los niveles de las operaciones de las aeronaves y de las actividades de los pasajeros, y los efectos medioambientales asociados se mantuvieron bien por debajo de los niveles analizados previamente para el aeropuerto Logan. Por lo tanto, el crecimiento de la aviación pronosticado presentado en el *ESPR de 2004,* la afirmación sobre la que se estableció inicialmente el cronograma del ESPR, no se produjo. En consecuencia, con la aprobación del secretario, Massport confeccionó los *EDR de 2009 y de 2010* en lugar del ESPR originalmente planeado para 2009. El *ESPR de 2011,* presentado a principios de 2013, informó sobre el año calendario 2011 y los pronósticos de los niveles actualizados de las actividades de los pasajeros y de las operaciones de las aeronaves. El *EDR de 2012/2013* conjunto presentó condiciones para ambos años calendarios 2012 y 2013. El *EDR de 2014,* el *EDR de 2015* y el *EDR de 2016* presentaron condiciones para los años calendarios 2014, 2015 y 2016.

Este *ESPR de 2017* proporciona un análisis integral acumulado de los niveles de actividad y de las condiciones medioambientales para 2017 y para el horizonte de planeación futura. Massport propone confeccionar un *EDR de 2018/2019* conjunto para informar los efectos de todas las actividades del aeropuerto Logan basadas en la actividad de pasajeros y en las operaciones de las aeronaves actuales en 2018 y en 2019, y la publicación anticipada para 2020. Si corresponde, Massport continuará identificando y abordando cualquier tendencia de aviación y medioambiental a largo plazo tanto en los EDR como en los ESPR. Como se indica en la certificación del secretario sobre el Formulario de notificación medioambiental (Environmental Notification Form, ENF) del proyecto de modernización de la Terminal E, el EDR/ESPR continuará siendo el foro para abordar los impactos acumulados de todo el aeropuerto.

30 Certificación del secretario de la Oficina ejecutiva de Asuntos Medioambientales sobre la actualización anual del aeropuerto Logan 1997, emitida el 16 de octubre de 1998.

Revisión específica del proyecto

Aunque esta revisión de todo el aeropuerto brinda el contexto de planificación más amplio para los proyectos propuestos y para los conceptos de planificación futuros, determinados proyectos del aeropuerto también están sujetos al proceso público de revisión medioambiental específico del proyecto cuando cumplen los umbrales de revisión medioambiental estatal. Cuando se solicita, los locatarios de Massport y del aeropuerto presentan el ENF y el EIR en virtud de la MEPA. De manera similar, cuando se desencadena la revisión medioambiental de la NEPA, se revisan los proyectos de acuerdo con el proceso de revisión medioambiental de la NEPA.[31]

Organización del *ESPR de 2017*

El resto de este *ESPR de 2017* incluye lo siguiente:

- **Resumen ejecutivo en español,** que proporciona una versión traducida del Resumen ejecutivo incluido después de la versión en inglés del Capítulo 1, *Introducción/Resumen* ejecutivo.
- **Capítulo 2, *Niveles de actividad,*** que presenta estadísticas de la actividad de la aviación para el aeropuerto Logan en 2017 y el horizonte de planeación futura con una comparación con años anteriores. Las mediciones de las actividades específicas analizadas incluyen pasajeros aéreos, operaciones de aeronaves, mezcla de flota y volúmenes de carga/correo.
- **Capítulo 3, *Planificación aeroportuaria*,** que brinda una descripción general de la planificación, de la construcción y de las actividades permitidas que se realizaron en el aeropuerto Logan en 2017. También describe la planificación, construcción, y actividades permitidas e iniciativas conocidas futuras.
- **Capítulo 4, *Transporte regional*,** que describe los niveles de actividades en los aeropuertos de Nueva Inglaterra en 2017 y actualiza las actividades de planificación regional recientes.
- **Capítulo 5, *Acceso terrestre desde y hacia el aeropuerto Logan*,** que informa la cantidad de pasajeros en el transporte público, las calles, los volúmenes de tráfico y el estacionamiento para 2017 y el horizonte de planeación futura con una comparación con años anteriores.
- **Capítulo 6, *Disminución del ruido*,** en el que se actualiza el estado del entorno sonoro en el aeropuerto Logan en 2017 y el horizonte de planeación futura con una comparación con los años anteriores, y describe las iniciativas de Massport para reducir los niveles de ruido.
- **Capítulo 7, *Calidad del aire/Reducción de las emisiones*,** que brinda una descripción general de la calidad del aire en relación con el aeropuerto en 2017 y el horizonte de planeación futura con una comparación con los años anteriores, y las iniciativas para reducir las emisiones.

31 42 USC Sección 4321 et seq. La Administración Federal de Aviación (FAA) implementa la NEPA mediante la ordenanza 1050.1E, Impactos medioambientales, de la FAA. Políticas y procedimientos, Administración Federal de Aviación, Departamento de Transporte de los Estados Unidos, fecha de entrada en vigor: 20 de marzo de 2006.

- **Capítulo 8, *Cumplimiento y manejo medioambientales/Calidad del agua*,** que describe las actividades del manejo medioambiental en curso de Massport, incluido el cumplimiento con el NPDES, los desagües pluviales, los derrames de combustible, las actividades del Plan para Contingencias de Massachusetts (Massachusetts Contingency Plan, MCP) y el manejo de tanques.
- **Capítulo 9, *Medidas que benefician al medioambiente y seguimiento del proyecto de mitigación***, que brinda una descripción general de los programas y de las iniciativas de Massport que proporcionan beneficios medioambientales e informa el progreso de Massport para cumplir la sección 61 de la MEPA[32] sobre los compromisos de mitigación de proyectos específicos del aeropuerto.

Apéndices de la MEPA estos incluyen la certificación del secretario de la EEA para el *EDR 2016,* las certificaciones del secretario para el *Aviso de cambio en el proyecto del EDR de 2016*, cartas con comentarios recibidas para el *EDR 2016* y las respuestas a esos comentarios, certificaciones del secretario para los informes anuales emitidos para los años de informe de 2011 a 2015, una lista de revisores a quienes se les distribuyó este *ESPR de 2017* y un alcance propuesto para el *EDR 2018/2019*. También se incluyen en esta sección las certificaciones del secretario para el ENF del proyecto de modernización de la Terminal E, evaluación medioambiental (Environmental Assessment, EA)/informe de impacto medioambiental (Environmental Impact Report, EIR) provisorios y EA/EIR finales, y la certificación del secretario para el ENF del proyecto de estacionamiento del aeropuerto Logan.

Apéndice A: certificaciones de la MEPA y respuestas a los comentarios[33]
Apéndice B: cartas de comentarios y respuestas
Apéndice C: alcance propuesto para el EDR 2018/2019[34]
Apéndice D: lista de distribución

Apéndices técnicos:[35] estos incluyen datos analíticos detallados y documentación metodológica para los diferentes análisis medioambientales presentados y realizados para este *ESPR 2017*.

Apéndice E: Niveles de actividad
Apéndice F: Transporte regional
Apéndice G: Acceso terrestre
Apéndice H: Disminución del ruido
Apéndice I: Calidad del aire/Reducción de emisiones
Apéndice J: Cumplimiento y manejo medioambiental/Calidad del agua
Apéndice K: Informes del control de precios para el período de valores máximos
Apéndice L: Memorando de la reducción del carreteo/carreteo con un solo motor en el aeropuerto Logan

Esta página se dejó intencionalmente en blanco

32 El Capítulo 30, sección 61 (M.G.L. 30, § 61) de las leyes generales de Massachusetts establece que todas las agencias deben revisar, evaluar y determinar los impactos medioambientales de todos los proyectos o actividades, y deben usar todos los medios prácticos y mediciones para minimizar el daño al medioambiente. Para los proyectos que requieren un informe de impacto medioambiental, los hallazgos de la sección 61 especificarán todas las posibles medidas que se pueden tomar para evitar o mitigar los impactos medioambientales y el cronograma de implementación anticipado para las medidas de mitigación.

33 Las certificaciones del secretario para el Formulario de notificación medioambiental para el proyecto de modernización de la Terminal E, EA/EIR provisorios y EA/EIR finales se incluyen el apéndice A. Por practicidad, Massport respondió a los comentarios que se relacionan con el EDR y el ESPR.

34 Massport propone combinar los años de informe 2018 y 2019 en el próximo EDR, en forma similar a los que se publicó en el *EDR de 2012/2013*. Este informe se publicaría a finales de 2020 y brindaría las condiciones medioambientales modelizadas para los años calendario 2018 y 2019.

35 Los apéndice técnicos están disponibles en el sitio web de Massport en www.massport.com.

Esta página se dejó intencionalmente en blanco.

2

Activity Levels

Key Findings

- Boston Logan International Airport (Logan Airport or the Airport) (and the aviation industry in general) has been experiencing strong growth, largely driven by the positive economic conditions in the Boston region, low unemployment, a strong, diverse economic base, and continued investment in commercial and residential real estate, particularly in life sciences, finance, healthcare, and higher education. The expansion of international routes served from Logan Airport supports the economic opportunities Massachusetts residents have by enabling them to reach dozens of markets throughout the world and improving competitiveness as a top-tier global location for business, research, education, technology, and tourism.[1]

- In 2017, air passenger activity levels at Logan Airport reached an all-time high of 38.4 million, an increase of 5.9 percent over 2016. Aircraft operations increased at a slower rate, totaling 401,371 in 2017, an increase of 2.6 percent over 2016 levels. This trend continued in 2018 with air passenger activity levels of 40.9 million and aircraft operations totaling 424,024. The growth is directly correlated to the strong national and regional economies. Aircraft operations remain well below the 487,996 operations in 2000 and the historic peak of 507,449 operations reached in 1998.

- From 2010 to 2017, the annual number of passengers at Logan Airport increased by about 40 percent, while the annual number of aircraft operations[2] increased at a slower rate, about 14 percent, due to increasing aircraft load factors. International passenger levels increased at a faster rate than domestic passenger levels in 2017. Domestic air passenger activity levels increased by 5.1 percent while international air passenger activity levels increased by 9.3 percent over 2016 levels.

- This *2017 Environmental Status and Planning Report (ESPR)* evaluates future operational and environmental conditions associated with a projected 50 million annual air passengers and 486,000 annual aircraft operations in the next 10 to 15 years (the Future Planning Horizon). Massport's forecast is consistent with the Federal Aviation Administration's (FAA's) Terminal Area Forecast; within the 10- to 15-year planning horizon, the FAA forecasts 50 million annual air passengers.

1 *Mass*Benchmarks. 2018. *The Journal of the Massachusetts Economy, Volume 20 Issue 2.*

2 An aircraft operation is defined as one arrival or one departure.

Introduction

Logan Airport plays a number of critical roles in the local, New England, and national air transportation systems. It is the primary airport serving the Boston metropolitan area, the principal New England airport for long-haul services, and a major U.S. international gateway airport for transatlantic services. Logan Airport is a key transportation and economic resource in the New England region, the State, and the Boston metropolitan area, which is home to a broad range of industries. The industries accounting for the largest share of employees include: healthcare and social assistance;[3] educational services; and professional, scientific, and technology services (which include Boston's growing biotech industry).[4] In 2017, Boston was declared the "#1 city in the U.S. for fostering entrepreneurial growth and innovation."[5] The contribution of innovation and business start-ups is also evident in the latest 2017 year-to-date economic growth estimates and reflects trends in increased employment and high-tech industries.

In addition to supporting the economic success of the State, Logan Airport and the airport industry are important elements in the state and regional economies. The *Massachusetts Statewide Airport Economic Impact Study Update,* completed by MassDOT in 2014 and most recently updated in 2019,[6] estimates that Massport airports contribute approximately $23.1 billion in output to the Massachusetts economy annually; of this output, 71 percent is due to Logan Airport alone.[7] Total output includes on-Airport businesses, construction, visitor, and multiplier effects.[8] Logan Airport supports over 162,000 direct and indirect jobs, while generating approximately $16.3 billion per year in total economic output.[9] In 2017, over 20,000 people were employed at Logan Airport. This included approximately 1,285 Massport airport staff and administrative employees[10].

This chapter reports on annual air traffic activity at Logan Airport in 2017, including air passengers, aircraft operations, aircraft fleet mix, and cargo volumes. Air traffic and passenger activity levels at Logan Airport are the basis for the evaluation of noise, air quality effects, and ground access conditions associated with the Airport. In this chapter, current activity levels at the Airport are compared to prior-year levels, and historical passenger and operations trends at Logan Airport dating back to 2000 are reviewed.[11] This *2017 ESPR* also updates previous forecasts completed in 2011 (documented in the *2011 ESPR*) and revises them based on current and predicted conditions. This chapter also includes a discussion of national aviation trends since 2000. The updated forecast

3 The Social Assistance subsector of the North American Industry Classification System includes Individual and Family Services; Community Food and Housing, and Emergency and Other Relief Services; Vocational Rehabilitation Services; and Child Day Care Services. U.S. Bureau of Labor Statistics. 2019. Industries at a Glance – Social Assistance: NAICS 624. https://www.bls.gov/iag/tgs/iag624.htm.

4 U.S. Census Bureau via DataUSA. 2017. Boston-Cambridge, Newton, MA-NH Metro Area profile. www.datausa.io.

5 U.S. Chamber of Commerce Foundation and 1776. 2017. *Innovation That Matters*. https://www.1776.vc/reports/innovation-that-matters-2017/

6 MassDOT Aeronautics Division. 2019. *Massachusetts Statewide Airport Economic Impact Study Update*. https://www.mass.gov/files/documents/2019/03/25/AeroEcon_ImpactStudy_January2019.pdf

7 *Ibid*.

8 Multiplier effects refer to the recirculation of money in the local economy after initially being spent by the Airport, its tenants, or tourists. This recirculation increases the overall impact of the Airport's operation on the local economy.

9 MassDOT Aeronautics Division. 2019. *Massachusetts Statewide Airport Economic Impact Study Update.* https://www.mass.gov/files/documents/2019/03/25/AeroEcon_ImpactStudy_January2019.pdf.

10 Massport, 2018. *Massachusetts Port Authority 2018 Comprehensive Annual Final Report*. Table S-11. https://www.massport.com/media/3029/mpa-fy18-cafr-final.pdf

11 Refer to Appendix E, *Activity Levels,* for available information dating back to 1980.

includes the consideration of changes in aircraft fleet mix, anticipated airline industry trends, and likely destinations to be served by Logan Airport air carriers. Similar to other ESPRs, this document provides an overview of Massport's updated forecasts for future passenger, aircraft, and cargo activities. The future forecasts will again be revisited during the next ESPR cycle (approximately five years after this *2017 ESPR*), as necessary.

The chapter specifically describes 2017 activity levels, historical trends, and projected future conditions for:

- Air passengers and aircraft operations at Logan Airport;
- Cargo and mail volumes at Logan Airport; and
- Airline service at Logan Airport.

Source: ACI, 2017; U.S. Department of Transportation T-100 Database, 2017.
Note: A U.S. international passenger gateway refers to a U.S. port of entry for passengers traveling internationally. Logan Airport ranks 12th among other U.S. airports with international service, in terms of total number of international enplaned passengers.

Logan Airport is an important origin and destination (O&D)[12] airport both nationally and internationally and is one of the fastest growing major U.S. airports in terms of number of passengers over the past five years.[13] From 2016 to 2017, U.S. passenger traffic grew by 3.5 percent, whereas Logan Airport experienced a passenger growth of 5.9 percent.[14] In 2017, passenger activity levels reached an all-time high of 38.4 million passengers and aircraft operations totaled 401,371, in direct response to the strong national and regional economies. In 2018, passenger activity levels reached 40.9 million and aircraft operations totaled 424,024. Despite the increase in passengers, aircraft operations at Logan Airport for both 2017 and 2018 remained well below the 487,996 operations in 2000 and the historic peak of 507,449 operations reached in 1998 (**Figure 2-1** and **Figure 2-2**). This has been the result of a steady increase in aircraft size at the Airport and improving aircraft load factors (passengers/available seats).[15]

12 "Origin and destination" (O&D) traffic refers to the passenger traffic that either originates or ends at a particular airport or market. A strong O&D market like Boston generates significant local passenger demand, with many passengers starting their journey and ending their journey in that market. O&D traffic is distinct from connecting traffic, which refers to the passenger traffic that does not originate or end at the airport but merely connects through the airport en route to another destination.

13 Between 2012 and 2017, Logan Airport was the 9th fastest growing airport in the U.S. in terms of domestic O&D traffic (U.S. Department of Transportation O&D Survey).

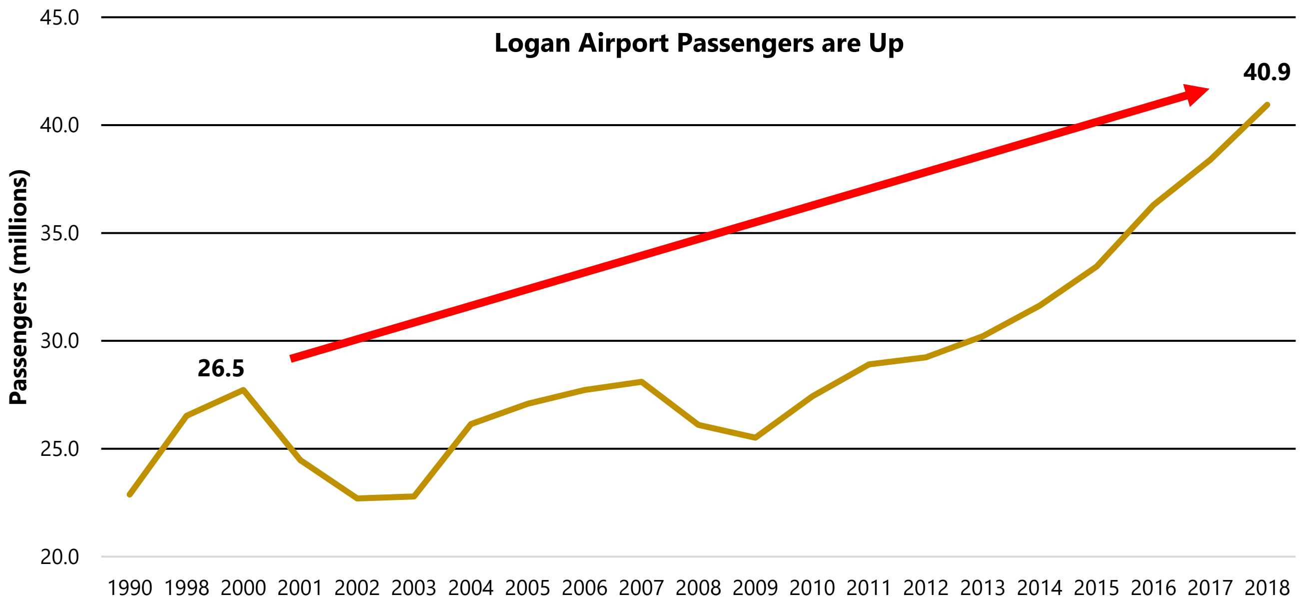
14 Airports Council International (ACI). 2017. *ACI North American Airport Traffic Summary*. http://www.aci-na.org/content/airport-traffic-reports.

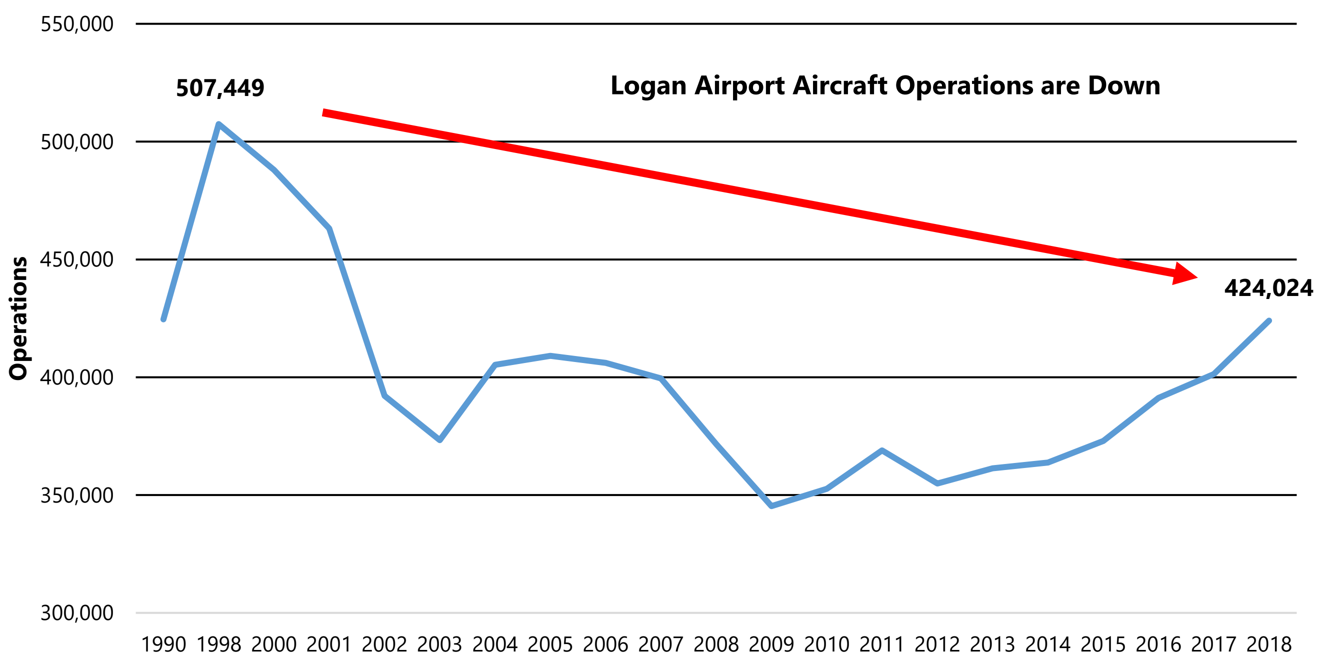
15 Load factor is the ratio of passengers on board to the number of available seats provided on a flight.

Figure 2-1 Logan Airport Annual Passengers and Operations, 1990, 1998, 2000, 2016–2018

Source: Massport.

Figure 2-2 Logan Airport Annual Passenger Levels Continue to Grow Faster than Aircraft Operations (1990, 1998, 2000–2018)



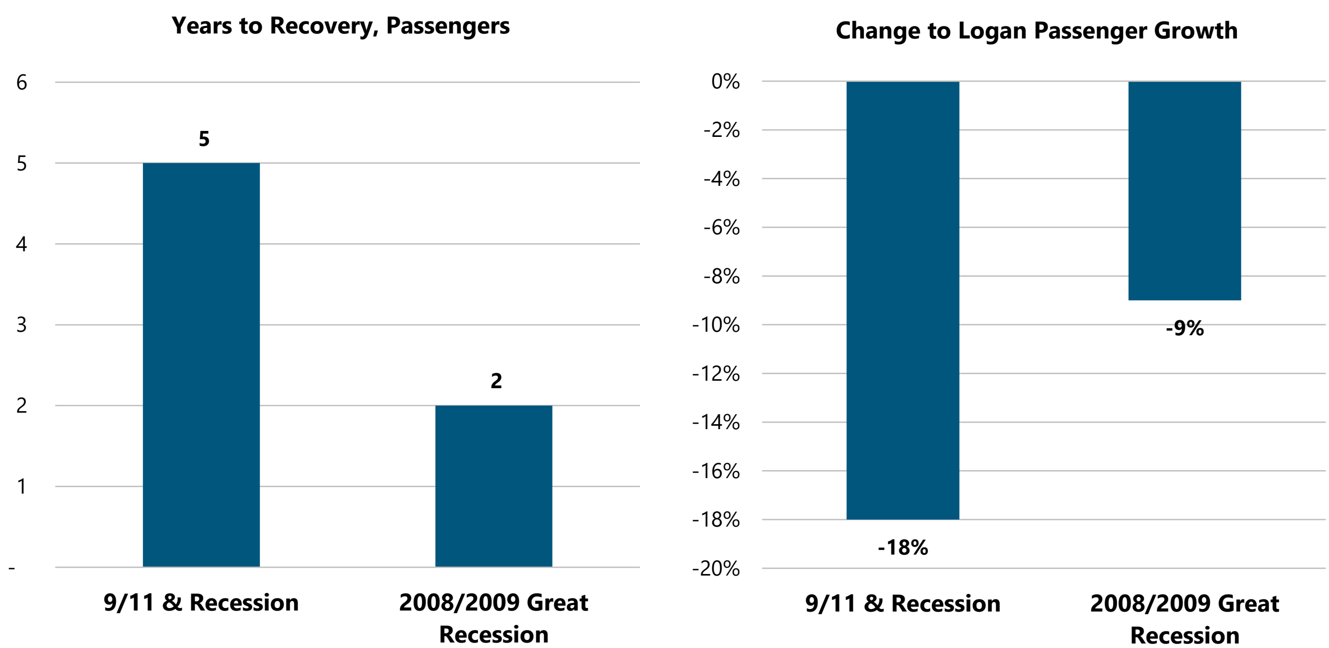


Source: Massport.

Additionally, economic and political events constantly affect the airline industry. Air traffic declines caused by economic recessions and other political "shocks" such as the events of September 11, 2001 and the Great Recession in 2008/2009 have been followed by gradual recovery cycles. The airline industry has experienced significant turmoil since 2000, seeing a wave of airline bankruptcies and reorganizations and periodic increases in oil prices. However, the industry continues to recover, and growth in air passenger activity levels has resumed.

As depicted in **Figure 2-3**, after the events of September 11, 2001 and the subsequent recession, Logan Airport's passenger activity levels declined by about 18 percent, yet recovered five years later. More recently, Logan Airport's passenger volumes declined by about 9 percent after the recession of 2008/2009. Recovery to pre-recession levels occurred in only two years, further demonstrating the resiliency of the Boston region economy.

Figure 2-3 Logan Airport Has Recovered Quickly After Recent Recessions



Source: InterVISTAS; Massport traffic statistics.

Air Passenger Levels in 2017

Logan Airport is the principal airport for the greater Boston metropolitan area, and the international and long-haul gateway for much of New England. Logan Airport was ranked the 16th busiest airport in the U.S. in terms of air passengers in 2017.[16]

Logan Airport served 38.4 million passengers in 2017, an increase of 5.9 percent over 2016. This represented a historic high for Logan Airport, exceeding the previous record of 36.3 million in 2016. Logan Airport is one of the fastest growing large airports in the U.S., where its average annual passenger growth of 5.6 percent since 2012 continues to outpace the overall U.S. passenger growth of 2.8 percent per year.[17] Factors that contributed to the strong passenger growth at Logan Airport in 2017 included:

- Continued economic growth and an increase in air travel demand across the nation, especially in Massachusetts and the Boston metropolitan area;
- Continued growth by air carriers jetBlue Airways' and Delta Air Lines' at Logan Airport; and
- Increasing international passenger demand and new international destinations.

As shown in **Table 2-1**, domestic air passengers represent Logan Airport's largest market segment, accounting for approximately 81 percent of total air passengers in 2017. The domestic passenger market increased by 5.1 percent in 2017 compared to 2016. Expansion in jetBlue Airways', Delta Air Lines', and Spirit Airlines' domestic networks from Logan Airport were the main contributors to increases in domestic passengers. jetBlue Airways served over 9.6 million domestic passengers at Logan Airport in 2017, compared to 8.8 million in 2016. Delta Air Lines carried 4.1 million domestic passengers in 2017, up 11.9 percent from approximately 3.7 million passengers in 2016. Spirit Airlines carried approximately 1.2 million domestic passengers in 2017, up 22.9 percent from 1.0 million passengers in 2016.[18]

Figure 2-4 shows the total annual passengers for the five major airlines at Logan Airport. Overall, the substantial low-cost carrier growth at the Airport over the past decade, particularly the entry of jetBlue Airways in 2004 and its subsequent decision to expand and make Logan Airport one of its focus cities, has exceeded recent consolidation and contraction among other carriers serving Logan Airport.[19] Domestic passenger activity levels have recovered from the economic downturn in 2008/2009 (the Great Recession), when the total number of domestic air passengers fell to 21.8 million. In 2017, domestic passenger activity levels reached a new peak of 31.1 million.

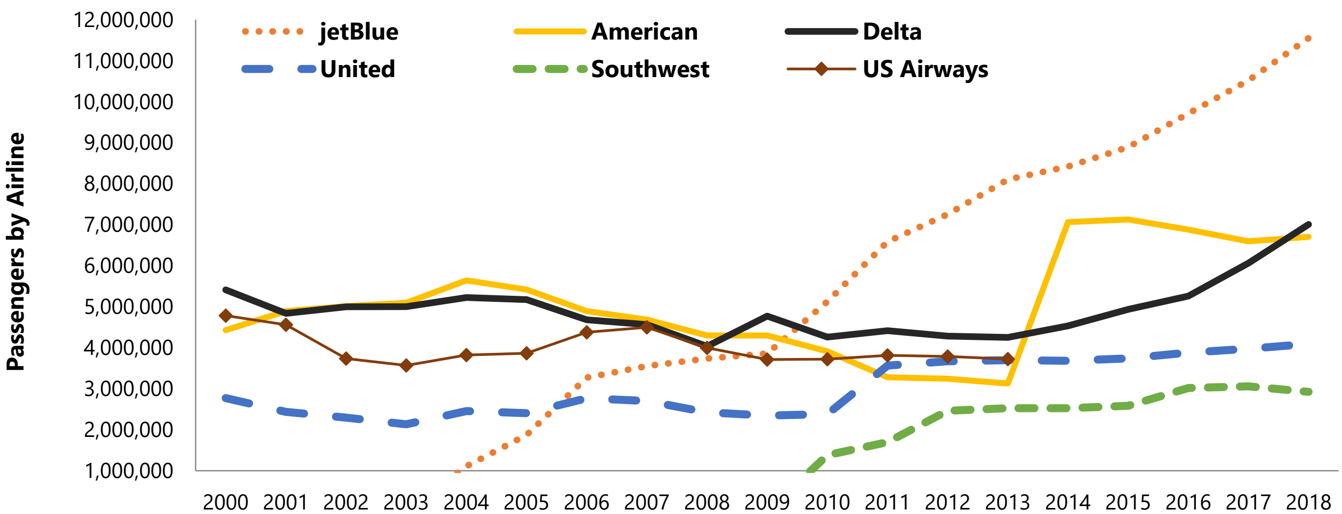
Despite the market dominance of domestic air passengers at Logan Airport, international passengers contribute a substantially higher share to the local and regional economies than domestic passengers do. Since 2010, international passenger traffic at Logan Airport increased by over 95 percent compared to an approximately

16 Airports Council International. 2018. World Airport Traffic Report.
17 Bureau of Transportation Statistics. 2018.
18 U.S. Department of Transportation. 2017. T-100 Database.
19 Airline industry consolidation includes the merger of Delta Air Lines and Northwest Airlines in October 2008, United Airlines and Continental Airlines in August 2010, Southwest Airlines and AirTran Airways in April 2011, American Airlines and US Airways in December 2013, and Alaska Airlines and Virgin America in December 2016.

31-percent increase in domestic passengers over the same time period. In 2017, Logan Airport welcomed 1.6 million overseas visitors, a 4.8-percent increase over 2016 levels.[20] New international service in the last five years alone has contributed more than $1.3 billion per year to the local economy and $49 million in new incremental income and sales tax revenue.[21]

International passenger traffic at Logan Airport, in particular, has increased by 9.3 percent over 2016 and 30.1 percent over 2015 levels. After three periods of decline and gradual recovery in 2001, 2006, and 2008, Logan Airport's international air passenger activity levels surpassed 2000 levels for the first time in 2013. In 2017, international passengers comprised approximately 19 percent of total Airport passengers. Since 2010, the international air passenger segment has averaged a 10.1-percent annual growth. This increase has been driven by strong market demand, resulting in the expansion of jetBlue Airways and Delta Air Lines' international service at Logan Airport, as well as a rapid increase in foreign carrier services in recent years. In 2017, Boston was the 12th largest U.S. gateway for international air travel and the largest U.S. gateway airport that is not a connecting U.S. airline hub.[22] The O&D strength of the Boston market makes Logan Airport an attractive gateway for international airlines. Additional trends in new aircraft technology allowing for smaller and more fuel-efficient aircraft on international routes are also expected to continue to benefit mid-size O&D markets like Boston.

Figure 2-4 Annual Passengers at Logan Airport Served by Top Airlines, 2000–2018



Source: Massport.

Notes: US Airways totals in this chart include America West Airlines beginning in 2006 (following 2005 merger), Delta Air Lines totals include Northwest Airlines beginning in 2009 (following 2008 merger), United Airlines totals include Continental Airlines beginning in 2011 (following 2010 merger), Southwest Airlines include AirTran Airways beginning 2012 (following 2011 merger), and American Airlines includes US Airways beginning in 2014 (following 2013 merger). Totals for American Airlines, Delta Air Lines, United Airlines, and US Airways include Delta Shuttle, US Airways Shuttle, and contract carriers doing business as Delta Connection, United Express, US Airways Express, American Eagle, or American Connection.

20 Greater Boston Convention and Visitors Bureau. Overseas Visitation. https://www.bostonusa.com/media/statistics-reports/overseas-visitation/.

21 Inter*VISTAS*. 2016. *Economic Impact of Recent International Routes.*

22 U.S. Department of Transportation. 2017. T-100 Database.

Table 2-1 Air Passengers by Market Segment, 1990, 1998, 2000, and 2010-2017

	1990	1998[1]	2000	2010	2011	2012	2013	2014	2015	2016	2017	Percent Change (2016-2017)	Avg. Annual Growth (2010-2017)
Domestic	**19,519,247**	**22,429,639**	**23,100,645**	**23,688,471**	**24,579,780**	**24,743,008**	**25,578,080**	**26,545,978**	**27,810,256**	**29,591,053**	**31,100,950**	**5.1%**	**4.0%**
International	**3,358,944**	**3,985,954**	**4,513,192**	**3,681,739**	**4,215,071**	**4,383,945**	**4,546,018**	**4,992,225**	**5,534,176**	**6,587,473**	**7,199,595**	**9.3%**	**10.1%**
Europe/ Middle East	N/A	2,467,585	2,948,452	2,672,635	2,939,226	2,896,002	2,901,529	3,194,109	3,473,579	4,096,114	4,360,706	6.5%	7.2%
Bermuda/ Caribbean[2]	N/A	702,383	693,620	518,088	700,267	793,953	863,842	887,301	946,428	1,032,330	1,100,769	6.6%	12.4%
Canada	N/A	790,731	833,669	486,911	573,660	614,879	643,987	669,546	688,459	878,191	1,000,634	13.9%	9.9%
Asia/Pacific	N/A	25,255	37,451[3]	0	0	78,484	104,235	170,867	316,621	415,869	503,386	21.0%	0.0%
Central/ South America	N/A	0	0	4,105	1,918	627	32,425	70,402	109,089	164,969	234,100	41.9%	78.2%
General Aviation	**N/A**	**111,115**	**112,996**	**58,752**	**114,416**	**109,134**	**94,872**	**96,242**	**105,148**	**109,516**	**111,874**	**2.2%**	**9.6%**
Total Passengers	**22,878,191**	**26,526,708**	**27,726,833**	**27,428,962**	**28,909,267**	**29,236,087**	**30,218,970**	**31,634,445**	**33,449,580**	**36,288,042**	**38,412,419**	**5.9%**	**4.9%**

Source: Massport.

Notes: Reported International passengers include only international passengers using Logan Airport as an international gateway; a significant number of international O&D passengers also board domestic flights from Logan Airport to connect to other U.S. gateways to international destinations.

N/A Not available.

1 1998 represents the historic peak in terms of aircraft operations for Logan Airport with 507,449 operations.

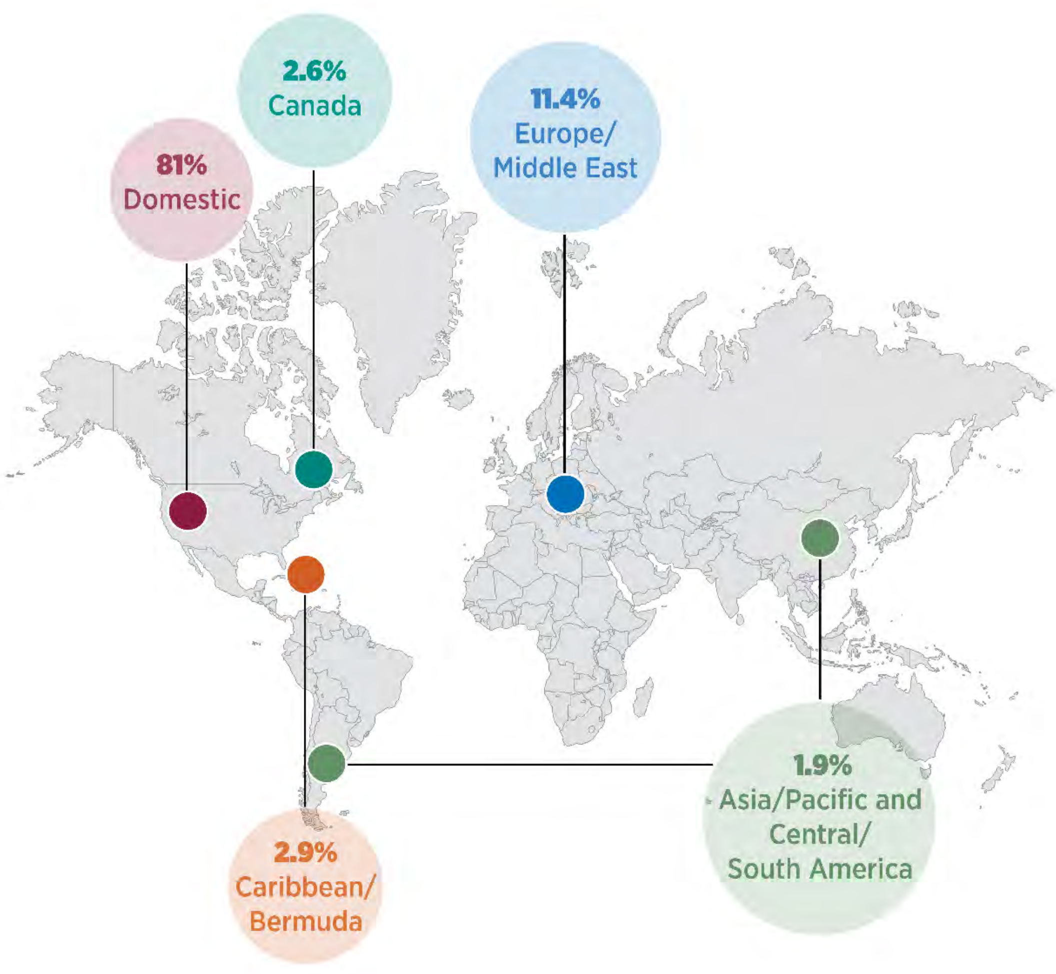
2 Includes Puerto Rico and U.S. Virgin Islands.

3 Between 1996 and 2001, Korean Air served Logan Airport with one-stop service via New York John F. Kennedy and Washington Dulles; this service was discontinued in February 2001.

Logan Airport has also attracted a significant amount of foreign carrier service, including new service by Emirates, Hainan Airlines, and Turkish Airlines in 2014, Aeromexico, Cathay Pacific, El Al, and WOW Air in 2015, Air Berlin, Norwegian Air Shuttle, Qatar Airways, Scandinavian Airlines, TAP Air Portugal, and WestJet Airlines in 2016, and most recently, Avianca and Air Europa in 2017.

Figure 2-5 shows the distribution of Logan Airport passengers by market segment. Europe/Middle East was the dominant international destination market, accounting for 60.6 percent of international traffic and 11.4 percent of total traffic at Logan Airport. Passenger traffic to Europe/Middle East was up 6.5 percent in 2017, driven by added capacity to Europe and other destinations by several European carriers. The Bermuda/Caribbean regions and Canada accounted for 13.9 percent and 15.3 percent of international passengers in 2017, respectively, with passenger traffic to Bermuda/Caribbean declining 3.1 percent and passenger traffic to Canada increasing 25.3 percent. Asia/Pacific and Central/South America passenger traffic accounted for 7.0 percent and 3.3 percent of international passengers in 2017, respectively.

Figure 2-5 Distribution of Logan Airport Passengers by Market Segment, 2017



Source: Massport.
Note: General aviation accounted for 0.3% of Logan Airport passengers in 2017.

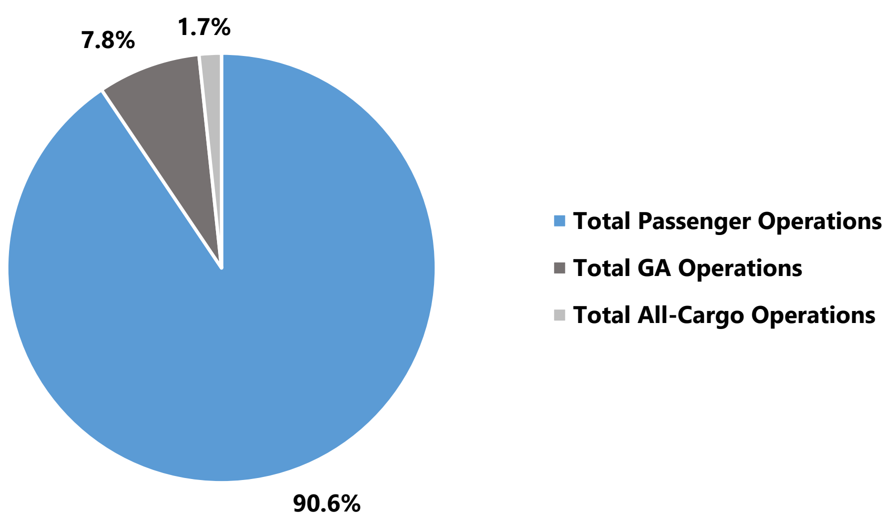
Aircraft Operation Levels in 2017

This section reports on aircraft operations levels for Logan Airport, including passenger aircraft operations, General Aviation (GA) operations, all-cargo aircraft operations, and aircraft load factors in 2017.

Logan Airport Aircraft Operations

The total number of aircraft operations at Logan Airport increased 2.6 percent, from 391,222 operations in 2016, to 401,371 operations in 2017 (**Table 2-2**). Increases were seen in passenger, GA, and all-cargo operations in 2017, driven by faster airline capacity growth. As shown in **Figure 2-6**, passenger operations account for 90.6 percent of total aircraft operations at Logan Airport, while GA and all-cargo operations account for 7.8 percent and 1.7 percent, respectively. **Figure 2-7** depicts passenger levels and aircraft operations since 1990 and shows a historical trend of increasing passenger levels and operations increasing, though not as rapidly as passenger activity levels. While passenger activity levels have reached historic highs the last several years, aircraft operations at Logan Airport are well below the historic peak of 507,449 operations in 1998. From 2001 to 2017, the annual number of passengers at Logan Airport increased by 56.9 percent, while the annual number of aircraft operations decreased by 13.3 percent, demonstrating the trend of increasing aircraft load factors by air carriers.

Figure 2-6 Logan Airport 2017 Aircraft Operations by Type



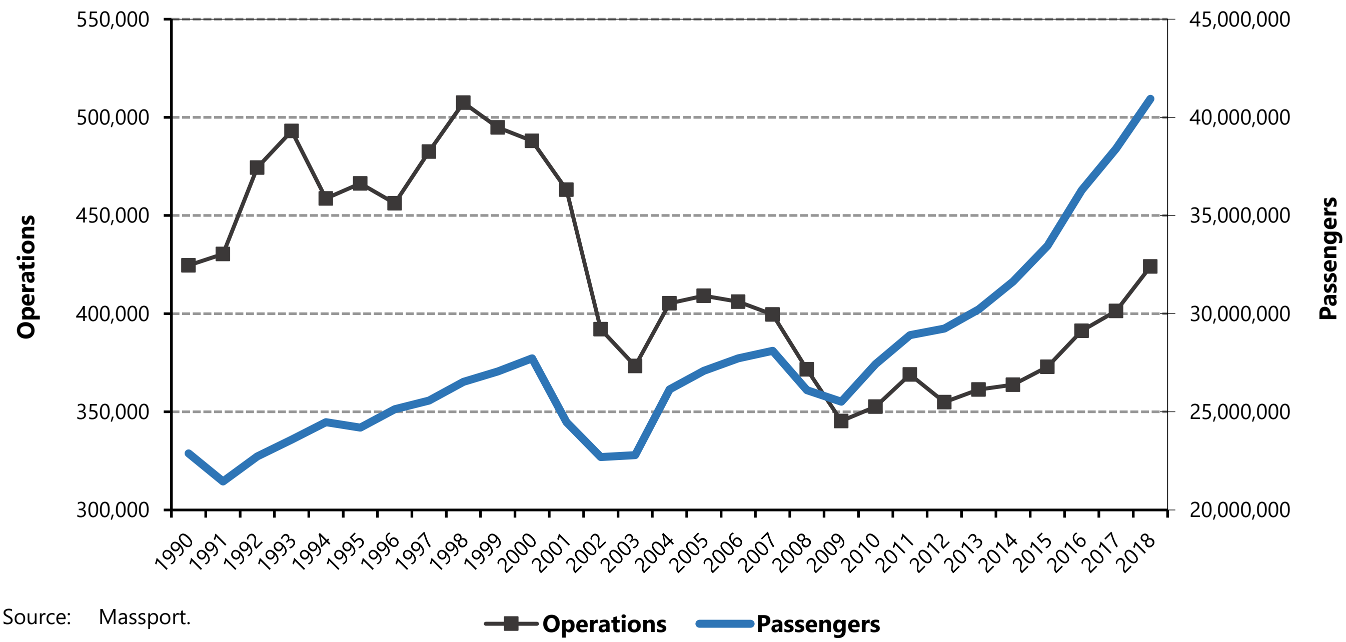
Source: Massport

Table 2-2 Logan Airport Aircraft Operations (1990, 1998, 2000, and 2010–2017)

Category	1990	1998[1]	2000	2010	2011	2012	2013	2014	2015	2016	2017	Percent Change (2016-2017)	Avg. Annual Growth (2010-2017)
Total Aircraft Operations	**424,568**	**507,449**	**487,996**	**352,643**	**368,987**	**354,869**	**361,339**	**363,797**	**372,930**	**391,222**	**401,371**	**2.6%**	**1.9%**
							Operations by Type and Aircraft Class						
Passenger Jet	N/A	242,927	254,968	214,307	223,083	225,166	233,072	240,252	254,250	270,330	279,464	3.4%	3.9%
Passenger Regional Jet	N/A	12,087	37,600	66,498	61,704	46,753	47,875	44,079	38,229	36,564	39,279	7.4%	(7.2%)
Passenger Non-Jet	N/A	209,665	147,913	50,882	49,700	49,599	48,307	47,339	46,225	46,868	44,764	(4.5%)	(1.8%)
Total Passenger Operations	**N/A**	**464,679**	**440,481**	**331,687**	**334,487**	**321,518**	**329,254**	**331,670**	**338,705**	**353,762**	**363,507**	**2.8%**	**1.3%**
GA Jet Operations	N/A	13,636	20,595	11,430	21,129	21,042	21,237	21,025	20,589	24,499	24,769	1.1%	11.7%
GA Non-Jet Operations	N/A	18,076	14,638	3,252	7,101	7,072	5,445	5,391	7,577	6,281	6,351	1.1%	10.0%
Total GA Operations	**24,976**	**31,712**	**35,233**	**14,682**	**28,230**	**28,114**	**26,682**	**26,416**	**28,166**	**30,780**	**31,120**	**1.1%**	**11.3%**
Cargo Jet	N/A	10,428	11,788	5,332	5,053	4,220	4,647	4,911	5,605	5,745	5,800	1.0%	1.2%
Cargo Non-Jet	N/A	630	494	942	1,217	1,017	756	800	454	935	944	1.0%	0.0%
Total All-Cargo Operations	**N/A**	**11,058**	**12,282**	**6,274**	**6,270**	**5,237**	**5,403**	**5,711**	**6,059**	**6,680**	**6,744**	**1.0%**	**1.0%**

Source: Massport.
Notes: Jet includes the Embraer E-190, which is a regional jet configured with 88 to 100 seats but similar in size to some traditional narrow-body jets.
Numbers in parentheses ( ) indicate negative numbers.
N/A Not Available.
1 1998 represents the historic peak in terms of aircraft operations for Logan Airport.

Figure 2-7 **Logan Airport Annual Passenger Levels Continue to Grow Faster than Aircraft Operations (1990–2018)**



Source: Massport.

Passenger Aircraft Operations

Logan Airport had 363,507 passenger aircraft operations in 2017, a 2.8-percent increase from 2016. The leading air carriers at Logan Airport, based on the number of aircraft operations in 2017, are shown in **Figure 2-8**. jetBlue Airways, American Airlines, Delta Air Lines, Cape Air, and United Airlines accounted for the majority of aircraft operations in 2017.[23] jetBlue Airways accounted for approximately 100,891 operations, American Airlines accounted for 58,354 operations, and Delta Air Lines ranked third with 58,201 operations. Cape Air, United Airlines, and Southwest Airlines ranked fourth, fifth, and sixth, respectively, with 33,235 operations, 27,441 operations, and 24,129 operations.[24]

Table 2-2 shows year-over-year changes in passenger regional jet (RJ), non-jet passenger, and passenger jet operations. RJ operations, which are jet aircraft with fewer than 90 seats, increased by 7.4 percent in 2017.[25] In general, RJ operations have been declining steadily since 2006, as airlines eliminated unprofitable services to small and medium size markets and consolidated services after a period of airline mergers. However, in 2017, RJ operations increased by 7.4 percent over 2016 levels due to low fuel prices, resulting in some airlines increasing the use of RJs on select routes.

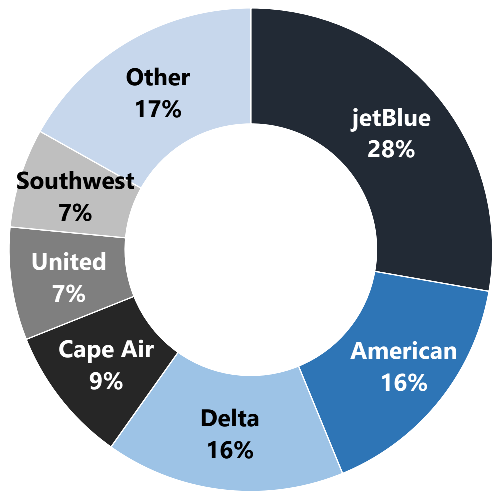
23 Aircraft operation numbers for airlines include regional partners and subsidiaries.

24 Total aircraft operations for American Airlines, Delta Air Lines, and United Airlines include regional affiliates and contract carriers.

25 In this report, the term regional jet refers to small jet aircraft with fewer than 90 seats. The Embraer-190, operated by jetBlue Airways at Logan Airport, carries up to 100 passengers and is considered a jet.

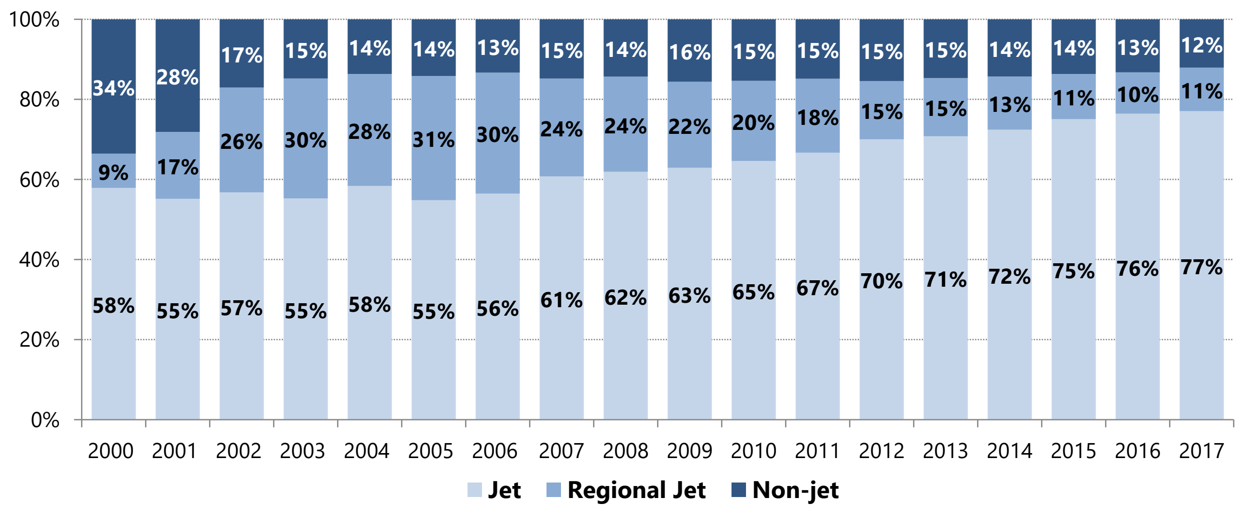
The change in mix of passenger aircraft operations since 2000 is shown in **Figure 2-9**. RJs accounted for 11 percent of total passenger operations in 2017, compared to 31 percent at the peak level in 2005. Similarly, non-jets operations have declined from 34 percent in 2000 to 12 percent in 2017.

Figure 2-8 Air Passenger Carriers at Logan Airport by Aircraft Operations, 2017



Source: Massport.
Notes: Totals for American Airlines, Delta Air Lines, and United Airlines include all regional affiliates and contract carriers. "Other" category includes all other carriers that have a smaller portion of aircraft operations at Logan Airport and that provide either year-round or seasonal service at Logan Airport.

Figure 2-9 Passenger Aircraft Operations at Logan Airport by Aircraft Type, 2000-2017



Source: Massport.
Notes: Jet includes the Embraer E-190, which is a regional jet configured with 88 to 100 seats but is similar in size to some traditional narrow-body jets.

Passengers per Aircraft and Load Factors

The average number of passengers per aircraft operation increased in 2017, continuing the long-term trend of greater efficiency. An increase in the average number of passengers per aircraft operation indicates an increase in the average aircraft seating capacity and/or an increase in the percentage of aircraft seats occupied by passengers (i.e., load factor[26]). Load factors at Logan Airport have matched or exceeded the national average each year since 2012. Changes in the number of passengers per operation and load factors at Logan Airport are shown in **Figure 2-10**. In 2017, Logan Airport operations accommodated an average of 95.7 passengers per flight compared to 92.8 in 2016 (**Table 2-3**). The average number of passengers per flight has risen by 22.8 percent since 2010 when the average number of passengers per flight was 77.8. The trend of more passengers on fewer flights is more efficient, reflecting a shift away from smaller, less fuel-efficient aircraft and rising load factors as airlines carefully monitored and restricted capacity growth. In 2017, Logan Airport's average domestic load factor was 82.6 percent, a slight decline from 2016 of 82.8 percent. The national average domestic load factor increased during the same period, from 81.7 percent in 2016 to 81.8 percent in 2017.[27]

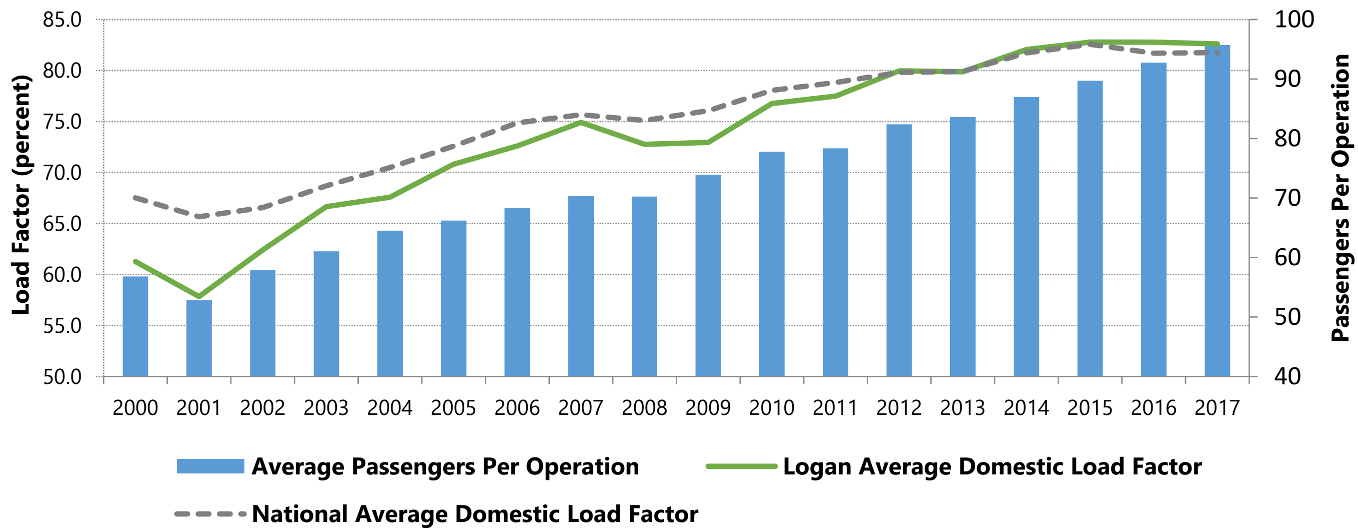
Table 2-3 Air Passengers and Aircraft Operations, 2000, 2010-2017

Year	Air Passengers	Percent Change from Previous Year	Aircraft Operations	Percent Change from Previous Year	Average Number of Passengers per Operation	Net Change from Previous Year (No. Pass/Op.)	Logan Airport Average Domestic Load Factor	Net Change from Previous Year (Pct. Points)
2000	27,726,833	2.5%	487,996	(1.4%)	56.8	2.1	61.3%	0.4
2010	27,428,962	7.5%	352,643	2.1%	77.8	3.9	76.8%	3.8
2011	28,907,938	5.4%	368,987	4.6%	78.3	0.5	77.5%	0.7
2012	29,235,643	1.1%	354,869	(3.8%)	82.4	4.1	80.0%	2.5
2013	30,218,631	3.4%	361,339	1.8%	83.6	1.2	79.9%	(0.1)
2014	31,634,445	4.7%	363,797	0.7%	87.0	3.4	82.1%	2.2
2015	33,449,580	5.7%	372,930	2.5%	89.7	2.7	82.8%	0.7
2016	36,288,042	8.5%	391,222	4.9%	92.8	3.1	82.8%	0.0
2017	38,412,419	5.9%	401,371	2.6%	95.7	2.9	82.6%	(0.2)

Source: Massport; U.S. Department of Transportation, T-100 Database.
Notes: Numbers in parentheses ( ) indicate negative numbers.
Includes scheduled passenger service only.
Refer to Appendix E, *Activity Levels,* for additional passenger and operations data dating back to 1980.

26 The number of passengers as a percentage of total seats operated at the airport.
27 U.S. Department of Transportation. 2017. T-100 Database; includes scheduled passenger service only.

Figure 2-10 Passengers per Aircraft Operation and Aircraft Load Factor are Increasing (2000-2017)



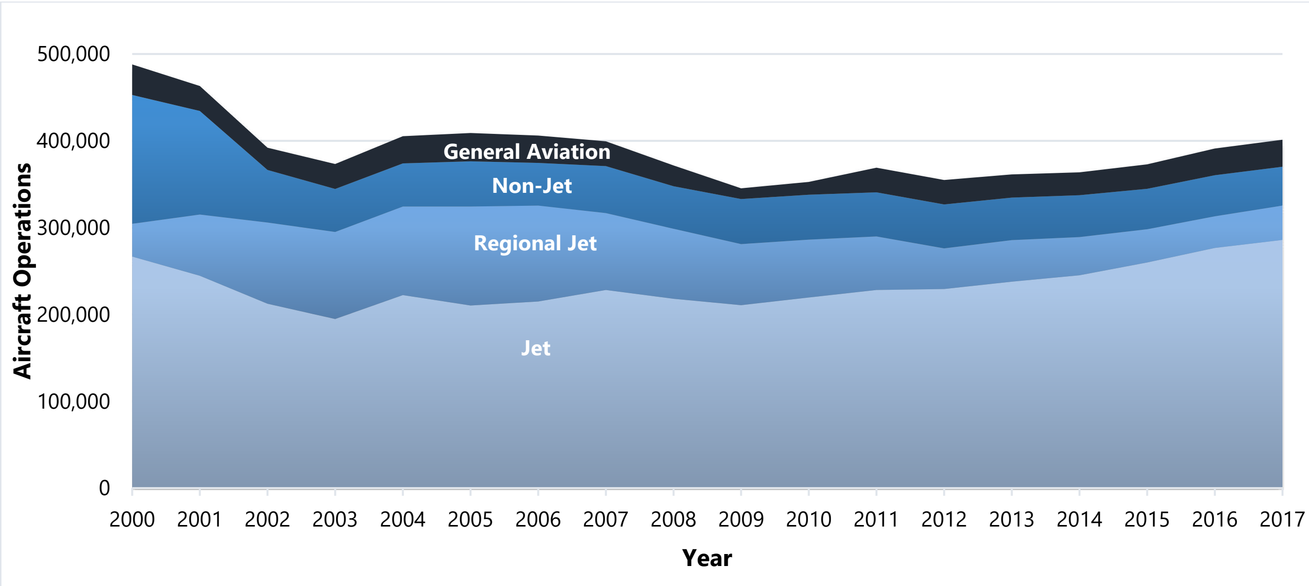
Source: Massport; U.S. Department of Transportation, T-100 Database.
Notes: Includes scheduled passenger service only.

General Aviation Operations

GA is defined as all aviation activity other than commercial airline and military operations. It encompasses a variety of aviation activities at Logan Airport, including: corporate/business aviation, private business jet charters, law-enforcement, and emergency medical/air ambulance services. GA operations are conducted by a diverse group of private and business aviation aircraft ranging from single-engine piston driven aircraft to high-performance, long-range jets. GA activity at Logan Airport declined following the 2008/2009 economic recession but recovered in 2011. Lower oil prices and decreased fuel expenses over the past two years have contributed to an increase in GA activity at Logan Airport. GA operation levels in 2017 remain well below the 35,233 GA operations that Logan Airport handled in 2000. In 2017, GA operations at Logan Airport totaled 31,120 operations, which increased 1.1 percent from the 30,780 operations in 2016.

Table 2-2 shows year-over-year changes in GA operations. Hanscom Field remains the primary GA airport for the Greater Boston region, accommodating over four times the number of GA operations at Logan Airport. Hanscom Field accommodated 127,723 GA operations in 2017, representing 99.3 percent of Hanscom Field's aircraft activity. **Figure 2-11** depicts changes in the number of Logan Airport aircraft operations by category since 2000.

Figure 2-11 Aircraft Operations at Logan Airport by Aircraft Class, 2000-2017



Source: Massport.
Notes: Jet, regional jet, and non-jet operations are associated with commercial passenger and all-cargo airlines.
GA operations also include jet and non-jet aircraft but are associated with private charter and corporate use.

All-Cargo Operations

Operations by cargo-dedicated aircraft represent less than 2 percent of aircraft activity at Logan Airport. **Table 2-2** shows year-over-year changes in all-cargo operations. All-cargo carriers at Logan Airport include FedEx, UPS, DHL, and a few other smaller carriers.

Airline Passenger Service in 2017

Airlines can adjust service at an airport or on a specific route in two ways: changing the number of flights operated or changing the size of the aircraft. Changes in flight frequency and changes in aircraft size both affect the number of seats available to passengers (seat capacity). Airline services are therefore typically discussed in terms of seat capacity as well as the number of flight departures.[28] This section examines changes in airline departures and seat capacity at Logan Airport in 2017 and provides an overview of new and discontinued routes.

Service Developments at Logan Airport

In 2017, 42 airlines provided scheduled passenger service from Logan Airport to 130 non-stop destinations.[29] The average non-stop stage length (the average length of non-stop flights) of scheduled domestic flights from Logan Airport decreased slightly from 994 miles in 2016 to 988 miles in 2017. The average non-stop stage length

28 A departure is an aircraft take-off at an airport. While aircraft operations include both departures and arrivals, airline services are typically described in terms of departures, as the number of scheduled departures generally equals the number of scheduled arrivals. Changes in departures translate to changes in overall operations.

29 Based on Official Airline Guide Schedules. The merger between Alaska Airlines and Virgin America was approved by the U.S. Department of Justice in December 2016. The airline will operate under the Alaska Airlines name in 2018.

of scheduled international flights decreased from 2,883 miles in 2016 to 2,859 miles in 2017. The major changes in Logan Airport's scheduled passenger services in 2017 are described below.

Changes in Domestic Passenger Service

The total number of scheduled domestic flights at Logan Airport in 2017 increased by 2.5 percent compared to 2016. Overall, scheduled jet operations by legacy carriers and low-cost carriers increased by 3.0 percent in 2017, and regional/commuter flights increased by 0.8 percent after a decline of 2.9 percent in 2016. **Table 2-4** shows year-over-year changes in domestic air passenger operations. Key changes in 2017 include:

- **Decrease in Legacy Carrier Service.** The decrease in legacy carrier jet operations reflects American Airlines' schedule adjustments in this market. In 2017, American Airlines reduced jet operations by 8.1 percent from the combined 55,249 operations performed by American Airlines and US Airways in 2016. However, American Airlines' RJ operations increased by 9.8 percent from 6,418 operations to 7,046 in 2017.
- **Increase in Low Cost Carrier Service.** Low-cost carriers accounted for over 42 percent of Logan Airport's total scheduled domestic operations in 2017.[30]
    - jetBlue Airways, the dominant low-cost carrier at Logan Airport, continued to expand, increasing its domestic operations by 10.5 percent from 84,590 operations in 2016 to 93,485 operations in 2017.
    - Ultra-low-cost carrier Spirit Airlines continued to expand its operations at Logan Airport, increasing domestic operations by 22.2 percent from 7,245 operations in 2016 to 8,853 operations in 2017. Since 2014, Spirit Airlines has increased domestic jet operations by 146 percent.
- **Slight Increase in Regional/Commuter Service.** Regional commuter flights slightly increased in 2017 due to increased operations by Republic Airlines (American Airlines, Delta Air Lines, and United Airlines regional affiliates) and Piedmont Airlines (American Airlines regional affiliate). Republic Airlines increased its overall operations by 718.7 percent in 2017 while Piedmont Airlines increased by 58.4 percent in 2017.
- **Planned Growth.** In 2018 and 2019, jetBlue Airways and Delta Air Lines announced plans for further growth in the number of operations and destinations offered.

30 Southwest Airlines decreased domestic operations by 1.3 percent from 24,436 operations in 2016 to 24,129 operations in 2017.

Table 2-4 Scheduled Domestic Air Passenger Operations by Airline Category, 2000, 2010-2017

Category	2000	2010	2011	2012	2013	2014	2015	2016	2017	Percent change 2016-2017	Avg. Annual Growth (2010-2017)
Scheduled Jet Carriers	233,993	203,081	207,369	203,376	211,176	214,854	225,629	235,381	242,404	3.0%	2.6%
Legacy Carriers[1]	222,564	117,877	111,761	108,374	107,162	109,470	114,987	114,012	110,790	(2.8%)	(0.9%)
Low-Cost Carriers[2]	11,429	85,204	95,608	95,002	104,014	105,384	110,642	121,369	131,614	8.4%	6.4%
Regional/ Commuter	160,041	94,535	89,586	79,790	79,922	76,682	70,274	68,204	68,753	0.8%	(4.4%)
Total Scheduled Domestic	**394,034**	**297,616**	**296,955**	**283,166**	**291,098**	**291,536**	**295,903**	**303,585**	**311,157**	**2.5%**	**0.6%**

Source: Massport.
Notes: Numbers in parentheses ( ) indicate negative numbers.
1 Includes legacy carrier large jet operations only; regional jet and non-jet operations operated by regional affiliates or subsidiaries of legacy carriers are included in the "Regional/Commuter" category.
2 Low-cost carriers that provided domestic service at Logan Airport in 2017 included jetBlue Airways, Southwest Airlines, Spirit Airlines, Virgin America, Sun Country Airlines, and Frontier Airlines.

Highlights of key domestic airline service changes at Logan Airport in 2017 include:

- **jetBlue Airways continued to grow operations from Logan Airport.** In 2017, the airline averaged over 130 daily departures. New domestic destinations introduced in 2017 included Atlanta. jetBlue Airways also added frequencies in markets including Nashville, New York, Pittsburg, and Salt Lake City. As Logan Airport's largest carrier, jetBlue Airways accounted for 29.4 percent of total domestic passenger aircraft operations and 30.7 percent of total passengers in 2017.
- **Delta Air Lines continued to add airline departures and seat capacity at Logan Airport**. In 2017, several new destinations were added along with new frequencies and capacity to several traditionally strong markets. Delta Air Lines began new non-stop service to Tampa, Buffalo, San Francisco, Pittsburgh, Kansas City, Norfolk, Austin, Jacksonville, and Fort Myers.[31] Delta Air Lines also added frequencies in the Orlando, Cincinnati, Salt Lake City, Los Angeles, Seattle/Tacoma, Milwaukee, Nashville, West Palm Beach, and Fort Lauderdale markets.
- **American Airlines reduced domestic operations and reduced capacity at Logan Airport.** The carrier did not discontinue any existing routes or add any new routes in 2017, but it did make several capacity adjustments. Overall, American Airlines reduced domestic seat capacity at Logan Airport by 4.1 percent in 2017. Frequencies were reduced in markets including Buffalo, New York John F. Kennedy International Airport (JFK), Philadelphia, and Syracuse. Capacity reductions were made in several other key markets such as Dallas/Fort Worth, Chicago Midway, and Harrisburg. American Airlines increased capacity to

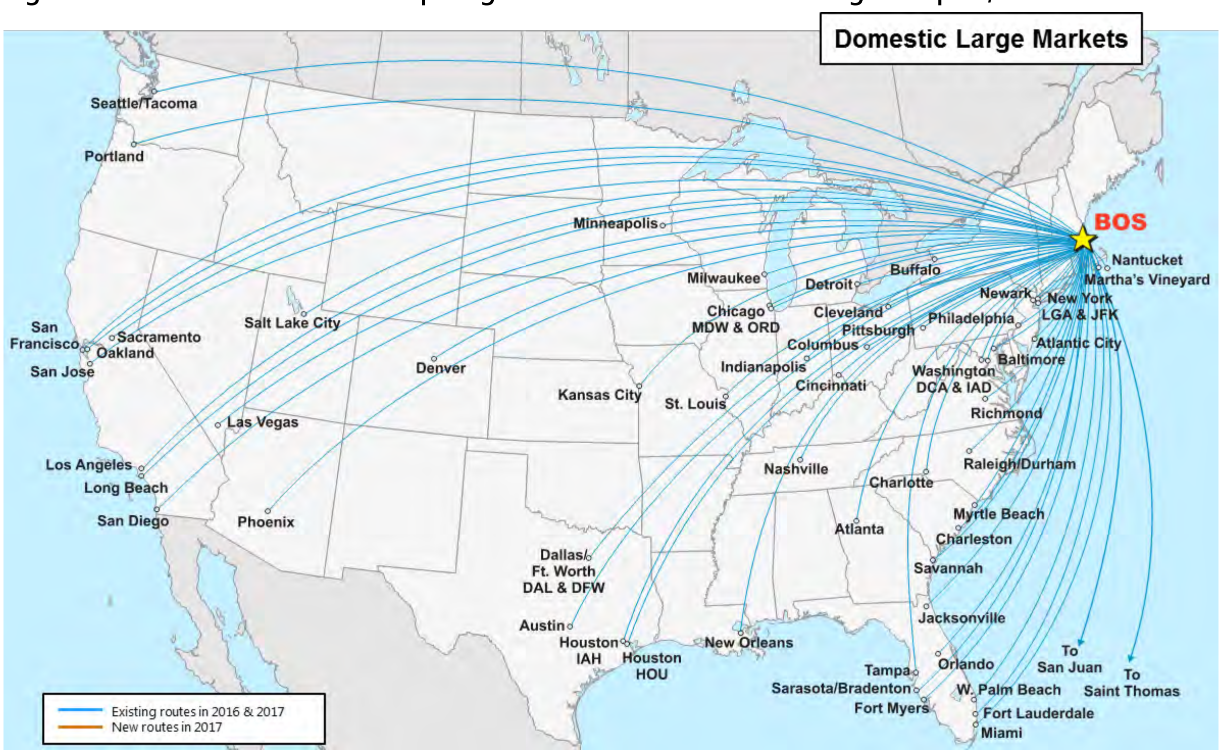
31 Service to Buffalo, Pittsburgh, Kansas City, Norfolk, and Jacksonville were served on regional jets.

Charlotte, Miami, Phoenix, Pittsburgh, Rochester, Syracuse, and Ronald Reagan Washington National Airport.

- **Spirit Airlines significantly expanded its network at Logan Airport in 2017, building on its strong growth in the previous several years.** Spirit Airlines increased total seat capacity by approximately 26.8 percent in 2017. The airline launched new service to New Orleans and Tampa in 2017 and increased frequency to Baltimore, Fort Lauderdale, Fort Myers, Orlando, and West Palm Beach.
- **Southwest Airlines increased seat capacity from Logan Airport in 2017, despite reducing operations.** Frequencies were reduced in markets including Chicago Midway, Columbus, Houston, Indianapolis, Kansas City, Milwaukee, and Orlando. However, additional capacity was added to markets such as Atlanta, Austin, Baltimore, Denver, Nashville, and St. Louis.

A complete listing of all changes in scheduled departures by domestic destination is in Appendix E, *Activity Levels*. Logan Airport's scheduled domestic large jet and domestic regional services are illustrated in **Figures 2-12** and **2-13**.

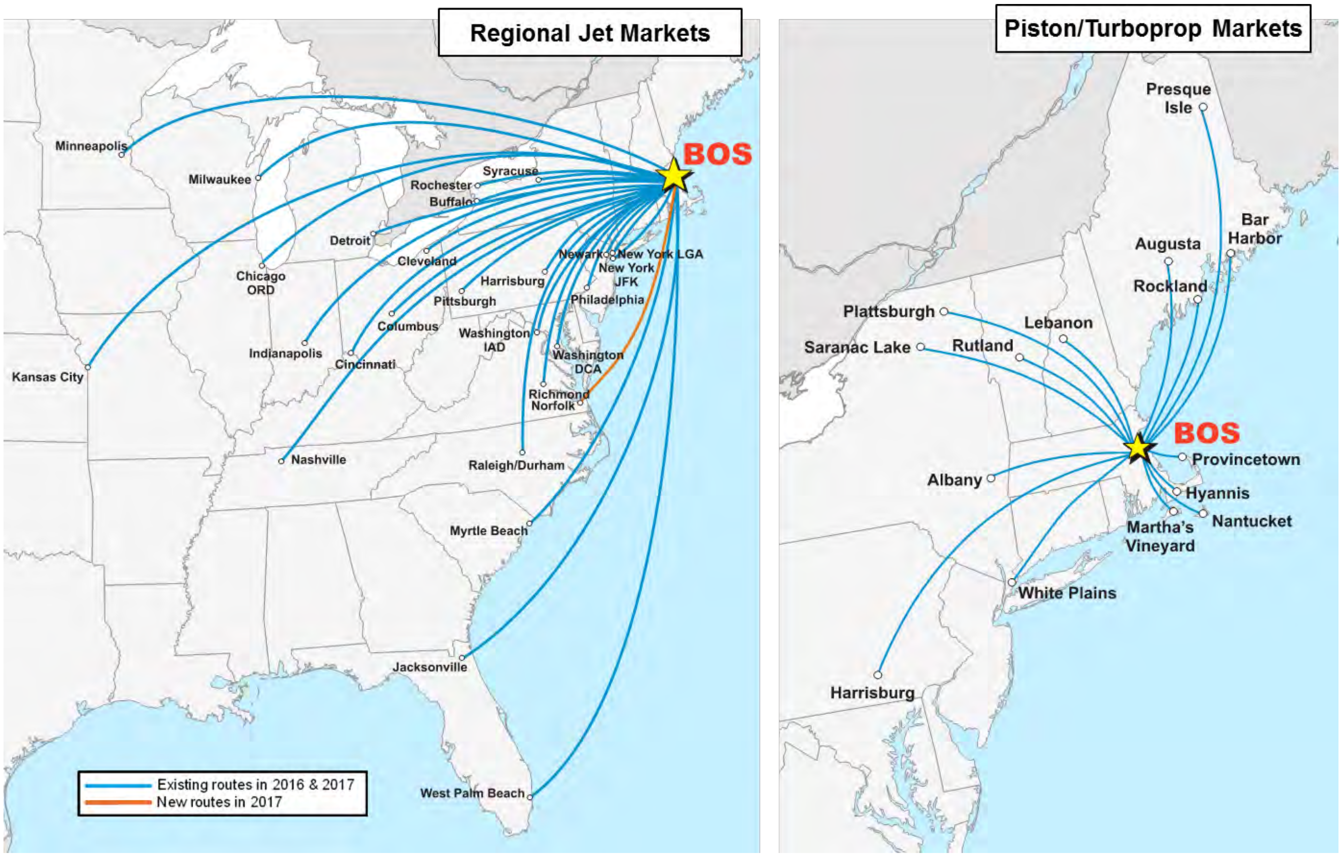
Figure 2-12 Domestic Non-Stop Large Jet Markets Served from Logan Airport, 2017



Source: Official Airline Guide Market Files.

Note: Delta Air Lines and United Airlines served only two total flights each during September 2016 and 2017 between Logan Airport and Madison, Wisconsin. There were no new domestic non-stop large jet routes in 2017.

Figure 2-13 Domestic Non-Stop Regional Jet and Non-Jet Markets Served from Logan Airport, 2017



Source: Official Airline Guide Market Files.

Changes in International Passenger Service

Total scheduled international passenger operations at Logan Airport grew by 4.3 percent in 2017. There were 52,119 scheduled international passenger operations at Logan Airport in 2017, up from 49,956 operations in 2016, as summarized in **Table 2-5** (for details on the changes in operations by carrier, see Appendix E, *Activity Levels*). Canada represents Logan Airport's largest international destination region in terms of aircraft operations, accounting for approximately 35.7 percent of total scheduled international passenger operations in 2017. This is primarily due to the high frequency service offered by Air Canada, Porter Airlines, and WestJet Airlines on large turbo-props and narrow-body aircraft to serve Canadian markets. **Table 2-5** shows year-over-year changes in scheduled international passenger operations by market segment. In 2017, passenger operations to Asia saw the largest increase in operations, followed by Central America. Passenger operations to Asia and Central America saw an increase in 2017 due to non-stop services introduced by foreign carriers over the past two years. Overall, Logan Airport served 55 non-stop international destinations in 2017, unchanged from 2016.[32]

32 International Air Transport Association (IATA). Innovata Schedules; SATA International had one-round trip scheduled between Boston Logan International Airport and Madeira International Airport in 2016 and 2017.

Table 2-5 Scheduled International Passenger Operations by Market Segment, 2000, 2010-2017

Category	2000	2010	2011	2012	2013	2014	2015	2016	2017	Percent change 2016-2017	Avg. Annual Growth (2010-2017)
Canada	26,067	16,399	16,290	16,787	16,125	15,748	15,801	17,929	18,590	3.7%	1.8%
Europe/Middle East	13,345	12,750	14,782	13,890	13,530	14,868	16,251	20,099	20,595	2.5%	7.1%
Bermuda/Caribbean[1]	3,205	4,116	6,054	6,752	7,031	7,428	7,584	8,339	8,690	4.2%	11.3%
Asia	0	0	0	474	646	1,011	1,751	2,156	2,415	12.0%	N/A
Central/South America	314	0	0	0	347	730	991	1,433	1,829	27.6%	N/A
Total Scheduled International	**42,931**	**33,265**	**37,126**	**37,903**	**37,679**	**39,785**	**42,378**	**49,956**	**52,119**	**4.3%**	**6.6%**

Source: Massport.
N/A Not Available.
1 Includes Puerto Rico and U.S. Virgin Islands.

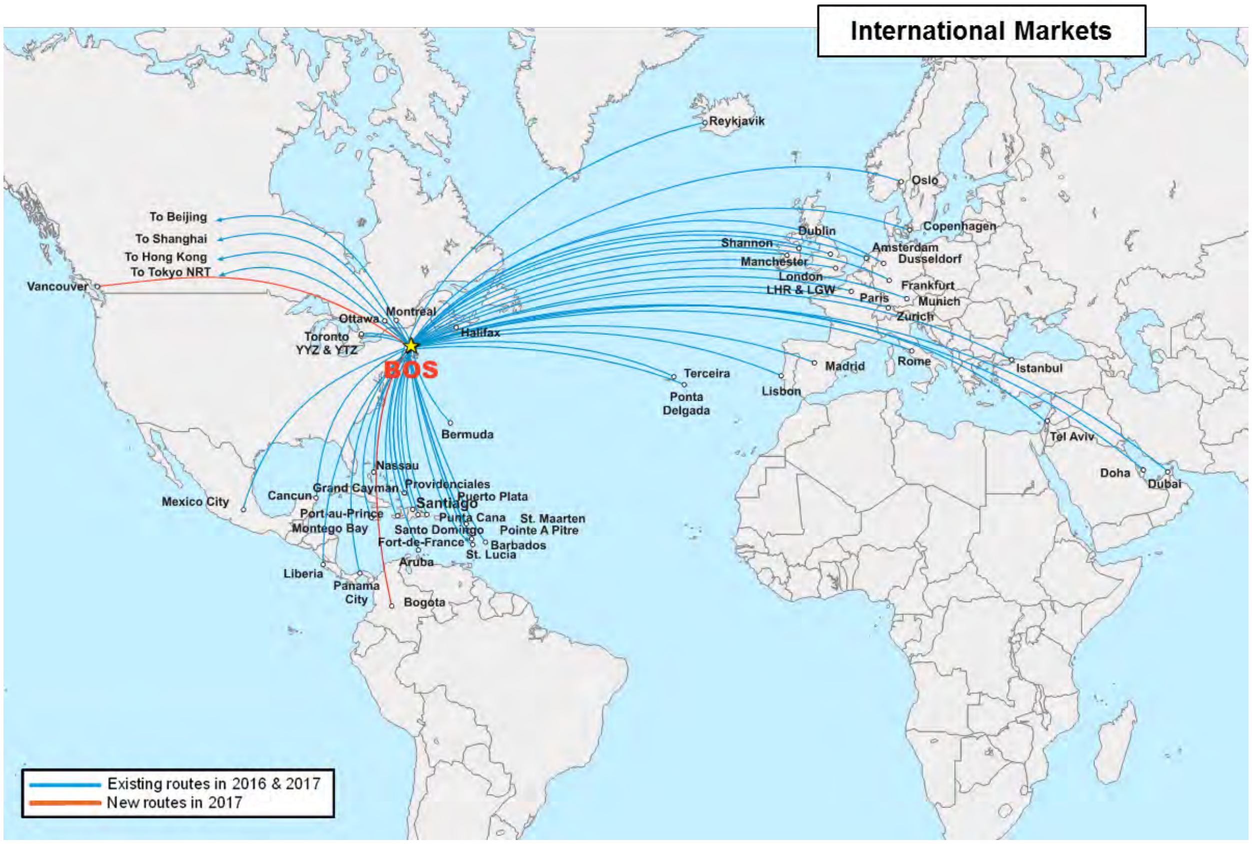
Changes in international service at Logan Airport in 2017 included continued growth of foreign carrier service. Logan Airport has seen a rapid increase in international service in recent years, with a number of new foreign carriers entering the market. In 2015, five new foreign carriers began service at Logan Airport: WOW Air, Cathay Pacific Airways, Aeromexico, El Al Israel Airlines, and Norwegian Air Shuttle. In 2016, seven additional foreign carriers launched at Logan Airport: Air Berlin, Eurowings, Scandinavian Airlines, Qatar Airways, TAP Air Portugal, Thomas Cook Airlines, and WestJet Airlines.[33] In 2017, two additional foreign carriers launched at Logan Airport: Avianca and Air Europa. New and expanded international passenger service at Logan Airport in 2017 included the following:

- Avianca introduced four weekly non-stop services to Bogota in June 2017, the first destination in South America and third in Latin America, in addition to Panama City and Liberia (Costa Rica).
- Air Europa, Air Canada, and WestJet launched new non-stop service to Madrid, Vancouver, and Montreal in 2017 (respectively).
- jetBlue Airways increased its international network at Logan Airport in 2017, with additional new routes to Bridgetown, Liberia (Costa Rica), Port Au Prince, Puerto Plata, and St. Lucia.
- American Airlines expanded Caribbean market segment with nonstop services to Cancun, Montego Bay, Punta Cana, and Providenciales.
- Delta Air Lines expanded its nonstop services to the Caribbean with flights to Nassau, Providenciales, Punta Cana, and Montego Bay.

Logan Airport's scheduled international air service markets are shown in **Figure 2-14**.

33 Foreign carriers Air Berlin and WOW Air went bankrupt in mid-2017 and early-2019, respectively.

Figure 2-14 International Non-Stop Markets Served from Logan Airport, 2017



Source: Official Airline Guide Market Files.
Note: Air Canada initiated new seasonal service between Vancouver and Boston in June 2017. Eurowings discontinued service between Cologne Bonn and Boston as of August 2016.

Cargo Activity Levels in 2017

In 2017, Logan Airport ranked 21st among U.S. airports in total air cargo volume.[34] Total air cargo volume[35] at Logan Airport increased to over 708 million pounds in 2017, compared to 640 million pounds in 2016. Air cargo is carried either in the belly compartments of passenger aircraft or by dedicated all-cargo carriers such as FedEx, UPS, and DHL in all-cargo aircraft. The express/small package segment continues to dominate Logan Airport cargo activity, accounting for 55.3 percent of the total non-mail cargo volume in 2017.

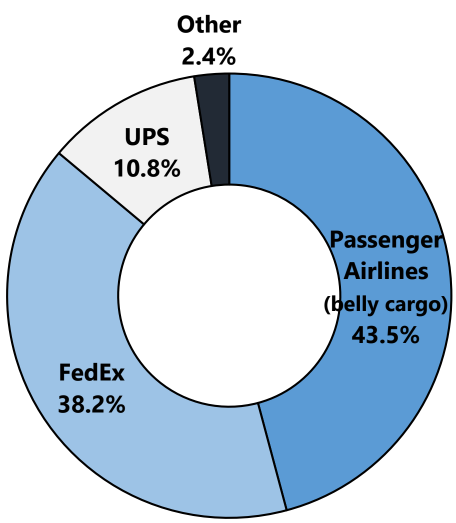
Table 2-6 shows all-cargo aircraft operations and cargo volumes at Logan Airport for 1990, 2000, and 2010 to 2017. In 2017, the number of all-cargo aircraft operations at Logan Airport increased by 1.0 percent while total cargo volume, including mail, increased 10.7 percent, reflecting an industrywide trend of growth in all-cargo segments: heavyweight, small package, e-commerce, and mail, in 2017.

34 U.S. Department of Transportation. 2017. T-100 Database. Total cargo volume includes mail.
35 Air cargo includes express/small packages, freight, and mail.

Compared to 2000, all-cargo operations at Logan Airport have declined by 45.2 percent, while total cargo volume has declined by 32.3 percent. Several factors are responsible for the decline over the last two decades in cargo shipments (including freight, express, and non-express mail and packages) at Logan Airport, as well as nationally. Cargo carriers, particularly the integrators that provide door-to-door delivery services, have significantly increased their use of trucks to move cargo in shorter haul markets because it is more cost-effective than air transport. In addition, the widespread acceptance and use of the internet and e-mail has greatly reduced mail volumes overall.

FedEx carried 38.2 percent of the total cargo volume through Logan Airport in 2017 and was the 14th largest air carrier at the Airport in terms of total flights.[36] UPS was the next largest cargo operator and accounted for 10.8 percent of Logan Airport's cargo volume in 2017. Passenger airlines carried 43.5 percent, or 308.5 million pounds,[37] of Logan Airport's cargo as belly cargo in 2017, compared to 400.2 million pounds that were shipped on all-cargo carriers (see **Figure 2-15)**.

Figure 2-15 Cargo Carriers – Share of Logan Airport Cargo Volume, 2017



Source: Massport.
Note: Passenger airlines carry cargo as belly cargo; other includes Atlas Air, Air Transport International, and ABX Air (which all fly for DHL).

36 Massport. 2019.
37 This includes express/small packages, freight, and mail.

Table 2-6 Cargo and Mail Operations and Volume (1990, 2000, and 2010–2017)

	1990	2000	2010	2011	2012	2013	2014	2015	2016	2017	Percent change (2016-2017)	Avg. Annual Growth (2010-2017)
All-Cargo Aircraft Operations	N/A	12,282	6,724	6,270	5,237	5,403	5,711	6,059	6,680	6,744	1.0%	0.0%
Volume (lbs.)												
Express/ Small Packages	N/A	484,490,143	339,485,424	332,896,322	327,234,464	334,315,119	356,743,626	336,013,472	352,551,369	376,009,078	6.7%	1.5%
Freight	N/A	367,857,011	206,893,979	204,055,228	204,596,956	203,877,671	228,716,329	239,768,129	264,382,330	303,398,899	14.8%	5.6%
Mail	119,818,113	194,902,513	25,904,205	24,566,806	21,546,316	19,407,738[1]	22,087,150	30,556,356	23,215,743	29,271,688	26.1%	1.8%
Total	**753,253,075**	**1,047,259,667**	**572,283,608**	**561,518,356**	**553,377,736**	**557,600,528**	**607,547,105**	**606,337,957**	**640,149,442**	**708,679,665**	**10.7%**	**3.1%**

Source: Massport.
N/A Not Available.
1 Number updated since publication of the *2016 Environmental Data Report (EDR)*. The number was previously reported inaccurately.

Future Aviation Activity Forecasts

This section presents Massport's updated long-range planning forecasts for passenger activity levels and aircraft operations for Logan Airport, as required by the Certificate of the Secretary of Energy and Environmental Affairs (EEA) on the *Boston Logan International Airport 2016 Environmental Data Report* (EDR). The methodology for the forecasts presented in this section is provided in Appendix E, *Activity Levels*. The forecasts are also compared to the previous planning forecasts presented in the *2011 ESPR*.

The updated forecasts include a base year of 2017 to reflect the current status of the airline industry as well as emerging trends that are expected to influence future aviation activities. Given the evolving aviation market and anticipated changes in the political and economic market, a specific future forecast year has not been determined; rather, Massport is considering a Future Planning Horizon for a 10- to 15-year timeframe. The future forecast was derived by applying standard industry forecasting techniques analyzing: 1) historical trends; 2) recent developments; and 3) outlook for future demand drivers such as the economy and airfares. The forecast is presented below and serves as the basis for the planning and environmental evaluation analyses in this *2017 ESPR*. The strategic planning forecasts include projections of passengers (domestic and international), aircraft operations (scheduled passenger, all-cargo, charter, and GA), and cargo.

National Aviation Trends

Major changes have occurred over the last several years in the U.S. aviation industry that have had a dramatic effect on individual markets. These changes affect air service at large airports such as Logan Airport, which are exposed to operational fluctuations by both domestic and international air carriers. Industry consolidation, a heightened focus on cost control and profitability, and aircraft fleet changes are all major factors that inform the forecast of future demand for a given market. The current state of the industry requires airport operators to be flexible in order to readily respond to activity shifts and continually satisfy demand while maintaining a high level of operational reliability.

Trends that have impacted the airline industry, and therefore Logan Airport, over the past decade include the state of the economy, industry consolidation, cost control, profitability, increases of low-cost carriers, and changes in aircraft fleets and load factors.

Strong Regional Economy[38]

The high percentage of O&D passengers in both the business and leisure markets at Logan Airport contrasts the percentage of O&D passengers at other major airports that airlines use primarily as connecting hubs. As a result of strong O&D demand, overall activity levels at Logan Airport are less vulnerable to fluctuations in connecting traffic resulting from route restructuring by airlines or other factors affecting select airlines. Rather, Logan Airport

38 Source for economic activity data is Woods & Poole Economics, Inc. 2018. Data Pamphlet – Boston-Cambridge-Newton, MA-NH.

activity levels tend to reflect general economic conditions, regional economic and demographic trends, and the economics of the airline industry.

The Boston metropolitan area was the 10th largest metropolitan area in the U.S. in terms of population in 2017, and it ranked ninth in the nation with 2.7 million employees. In 2017, Boston had an unemployment rate of 3.4 percent, below the national average of 4.5 percent and 6.4 percentage points lower than the national peak of 9.8 percent in January 2010. The unemployment rate in the Boston metropolitan area was the third lowest among the nation's large metropolitan areas (those with populations larger than one million).

The following six major sectors have contributed to the greater Boston region's economic growth since the early 1990s and currently account for one half of the Boston area employment base:

- High Technology
- Biotechnology
- Health Care
- Financial Services
- Higher Education
- Tourism

The Boston metropolitan area's average per capita personal income in calendar year 2017 was 30 percent above the national average and 4 percent higher than the New England average. During the period from 2000 to 2017, per capita income in Massachusetts grew slightly faster than in the U.S. as a whole. It is projected to grow at a rate of 1.5 percent annually through 2030, compared to the national U.S. projected growth of 1.4 percent. In summary, Boston's strong economy will continue to be the major driver of Logan Airport's passenger growth.

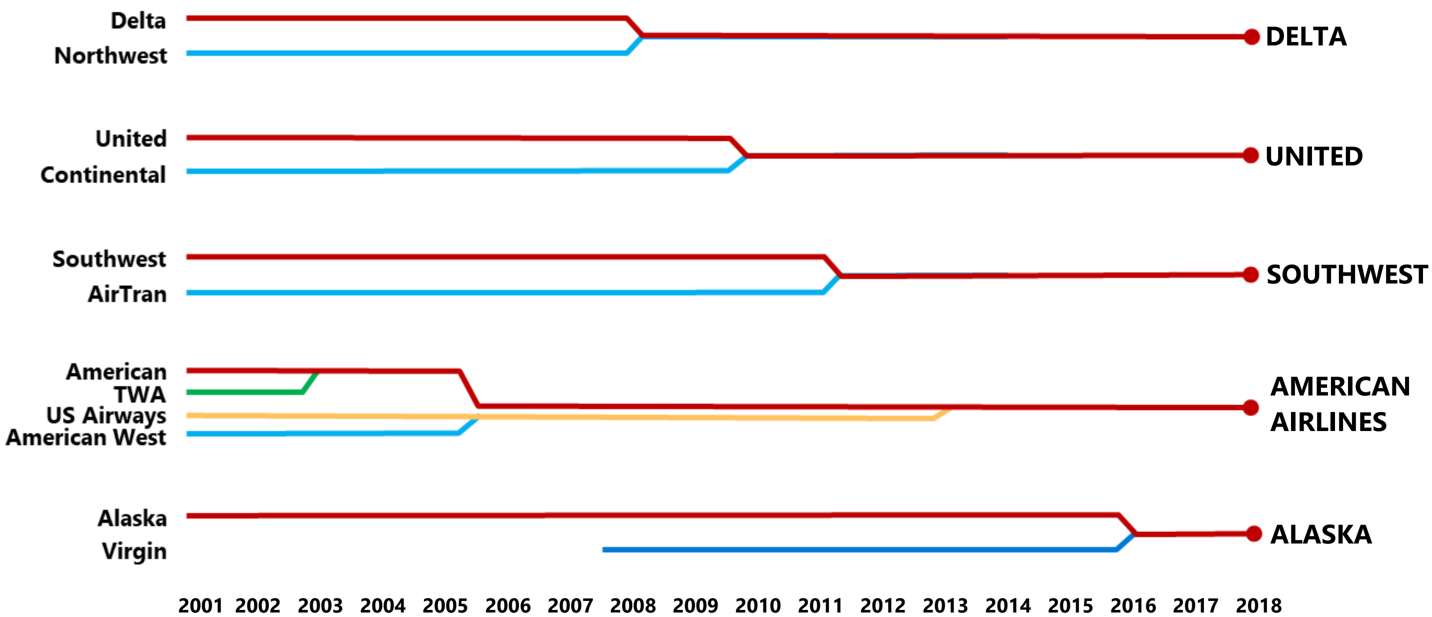
Airline Consolidation

In recent years, there has been a wave of airline mergers in response to competitive pressures. These mergers are shown in **Figure 2-16**.

As a result of these mergers, only four airlines (American Airlines, Delta Air Lines, Southwest Airlines, and United Airlines) and their regional carriers control more than 80 percent of all domestic air traffic. These mergers have an impact on the service provided in different markets, as airlines effectively consolidate the number of airports at which they connect passengers.

Should the airline industry consolidate further, because of the underlying strengths of the Boston market, Logan Airport has a relatively low risk of losing passenger traffic, beyond some inevitable short-term disruptions. Logan Airport serves a market with a large local O&D passenger base, with above average income levels, a travel intensive economic base, and attractiveness as a destination market. In addition to these market fundamentals, jetBlue Airways and Delta Air Lines continue to build a strong presence at Logan Airport and their anticipated growth over the next five years is expected to offset any potential negative effects of future consolidations.

Figure 2-16 Consolidation of the U.S. Airline Industry, 2000-2018



Source: Carrier Financial Reports.

Cost Control and Focus on Profitability

Airlines have returned to profitability for the past eight years, after two years of poor financial results, resulting from the recession in 2008/2009 (**Figure 2-17**). The recession of 2008/2009, and the subsequent fuel price hike, forced airlines to adopt cost control measures to compensate for the uncontrollable cost of fuel, which became, and still is, the largest cost category for airlines.

Airline focus on profitability has also included strategies to diversify revenue, such as additional fees for baggage, on-board food sales, assigned or preferred seats, and most recently, revenue associated with co-branded credit cards. Combined, these additional fees fall under the ancillary revenue category. For major airlines, including American Airlines, Delta Air Lines, and United Airlines, this additional ancillary revenue is estimated to be $5 billion for each airline, which represents approximately one-third of its total revenue. For low-cost airlines, such as Frontier Airlines and Spirit Airlines, this additional revenue represents nearly half of total revenue. The airlines' collective focus on financial performance and cost control measures is expected to continue for the foreseeable future.

Low-Cost Carriers (LCC) and Ultra Low-Cost Carriers (ULCC)

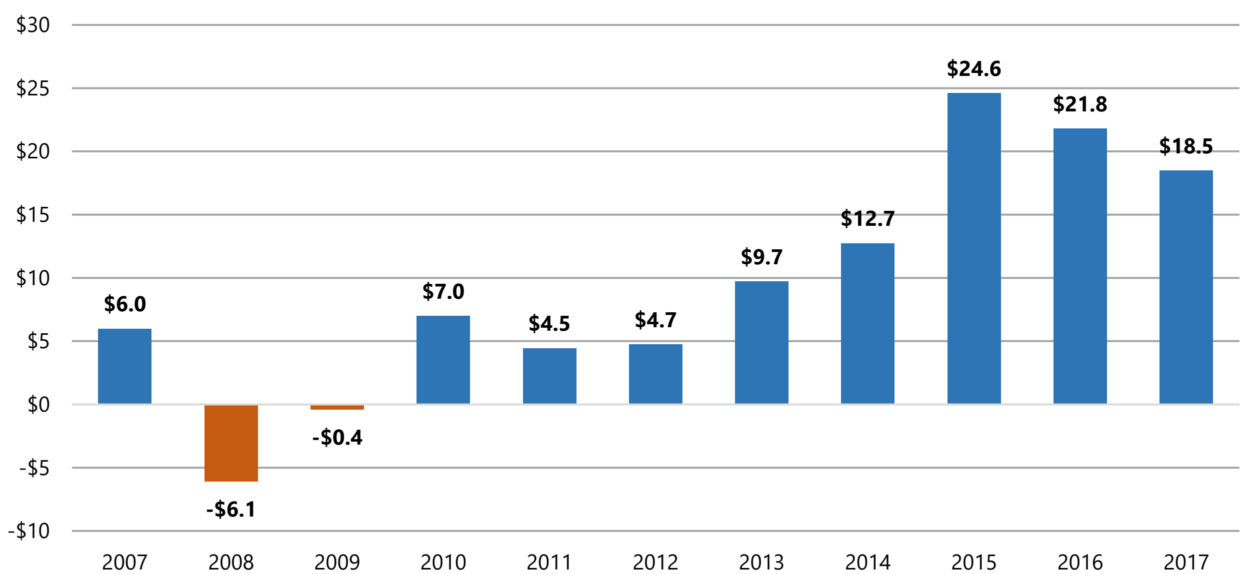
LCCs and ULCCs continue to expand rapidly and gain market share in the domestic market. The formation of carriers, like Allegiant Air, Frontier Airlines, jetBlue Airways, Southwest Airlines, and Spirit Airlines, has popularized

the low-cost business model. As shown in **Figure 2-18**, LCCs and ULCCs provided 27 percent of domestic seat capacity in the U.S. in 2007. In 2017, LCCs and ULCCs accounted for 33 percent of domestic seats. While rising fuel prices and the economic downturn forced legacy carriers to cut back on domestic capacity and focus on more profitable international flying, LCCs and ULCCs increased their domestic market share. Between 2007 and 2017, LCCs and ULCCs added a total of approximately 47 million domestic seats to their route systems. In comparison, the network airlines, comprising American Airlines, Delta Air Lines, United Airlines, and Alaska Airlines, reduced domestic capacity over the same period by a combined 49 million seats.

As shown in **Figure 2-19**, the LCC and ULCC market share at Logan Airport has risen dramatically. At the beginning of the last decade, LCCs and ULCCs had only a minimal presence at Logan Airport. The jetBlue Airways operation at Logan Airport was still in its early stages of establishing a presence. In 2009-2010, there was an increase in the LCC and ULCC share when Southwest Airlines and Virgin America initiated services at Logan Airport, while jetBlue Airways continued to expand its operations. Since then, the LCC and ULCC market share has continued to climb as jetBlue Airways increases activity levels and other LCCs and ULCCs add services at Logan Airport.

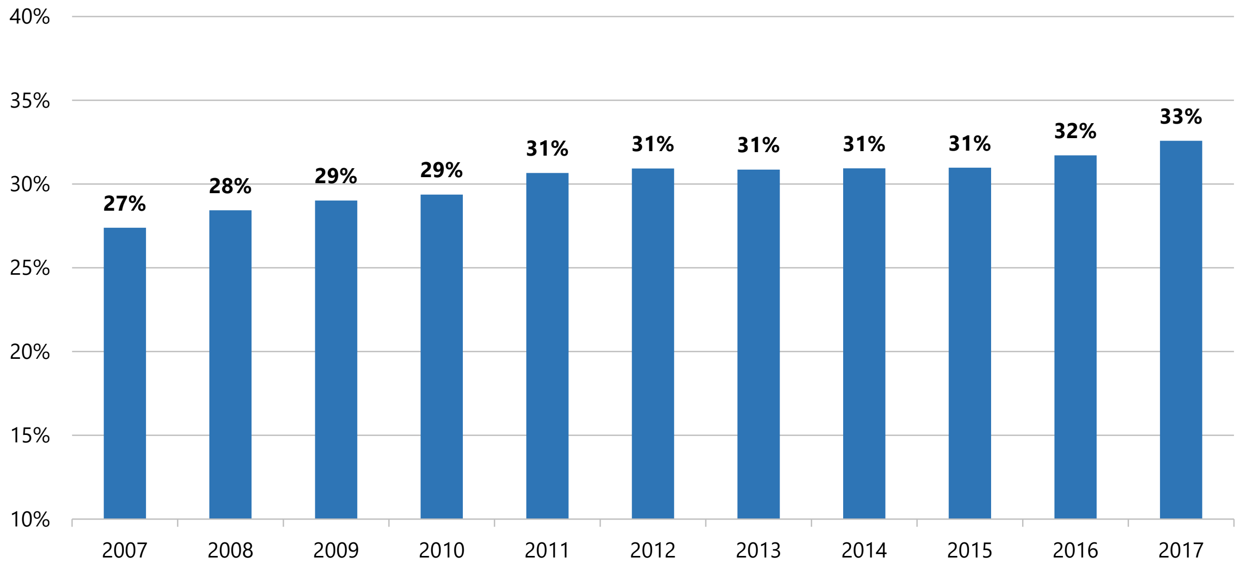
The lower operating cost advantage of LCCs and ULCCs compared to legacy carriers has enabled the rapid growth of LCCs and ULCCs over the past decade. These operating cost advantages result from differences in network structure, overhead cost, and crew seniority between the two carrier groups. However, the lines between LCCs and ULCCs and legacy carriers are beginning to blur. The lowering of legacy carrier cost structures and consolidation of carrier networks has allowed legacy carriers to compete on a more equal footing with the LCCs and ULCCs.

Figure 2-17 U.S. Airline Annual Operating Profits, 2007-2017



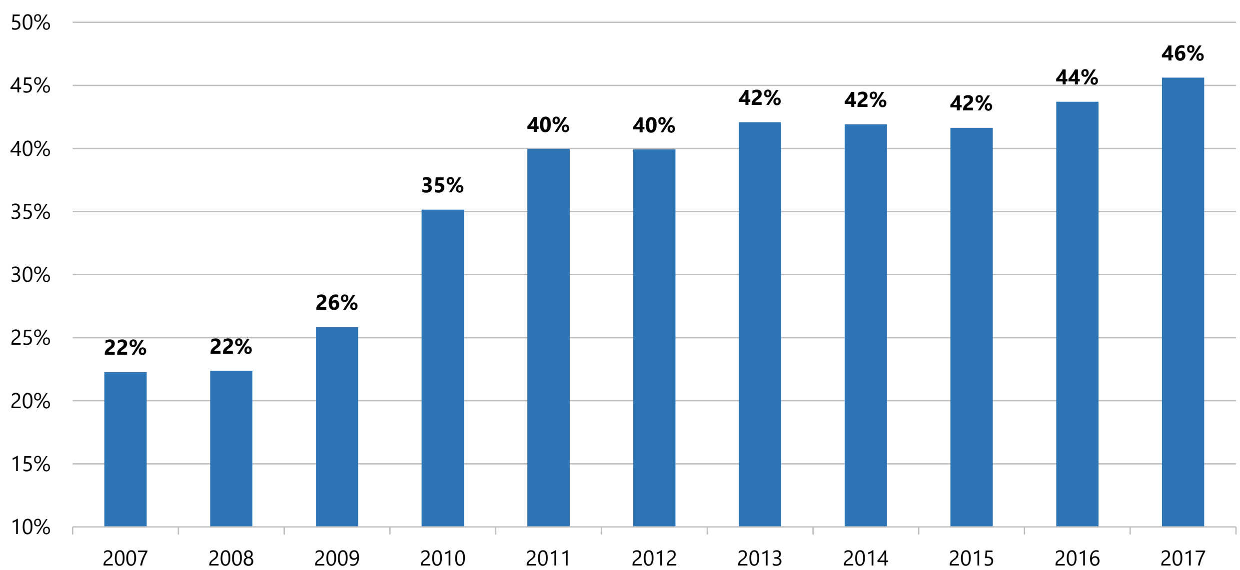
Source: Carrier Financial Reports.

Figure 2-18 Low-Cost and Ultra Low-Cost Carriers Have Increased Share of Total U.S. Domestic Seats, from 2007-2017



Source: Innovata Schedules, via Diio.

Figure 2-19 Low-Cost and Ultra Low-Cost Carrier Have Increased Share of Logan Airport Domestic Seats, from 2007-2017



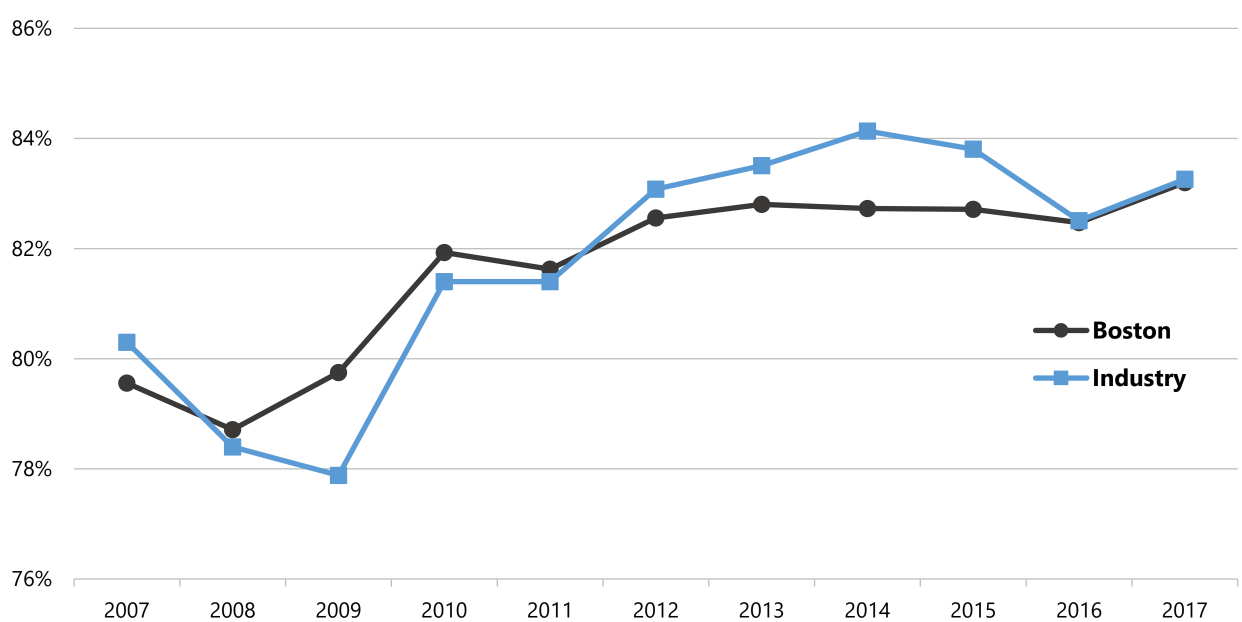
Source: Innovata Schedules, via Diio.

Aircraft Fleet Changes and Aircraft Load Factor

Given the focus on cost control, many airlines are replacing aging aircraft with more fuel efficient, modern models. Simultaneously, airlines are increasing the number of seats on aircraft in an effort to serve more passengers per flight. Small RJs (50 seats or fewer) have been phased out at Logan Airport at a more rapid rate than the U.S. average, contributing to increases in average numbers of seats per departure. This trend resulted in lower total operations at Logan Airport compared to historic peaks, while passenger activity levels have continued to grow, resulting in more efficient operations. Passenger enplanements at Logan Airport have increased from an average of 89.4 per departure in 2012 to 103.5 in 2017, whereas the number of seats per departure have increased from 112.8 to 124.4 over the same five-year period. Average seats per departure are expected to continue to increase as experienced in recent years.

Since 2008, Logan Airport has seen increasing load factors, reaching a historic high of 83.2 percent in 2017 (**Figure 2-20**). These rising load factors are a result of Logan Airport's growth in passenger demand, which has exceeded the increase in airline seating capacity. North American (Domestic, Caribbean, Canada, and Mexico) load factors at Logan Airport are 5.4 percentage points higher than the international load factors in 2017, 85.2 percent compared to 79.8 percent. This trend is expected to reverse in the future. North American load factors at Logan Airport are forecast to increase modestly to 86.6 percent in the Future Planning Horizon, while international load factors are expected to grow by 7.8 percent to 87.6 percent.

Figure 2-20 Total Load Factors, Logan Airport Compared to the Industry, 2007-2017

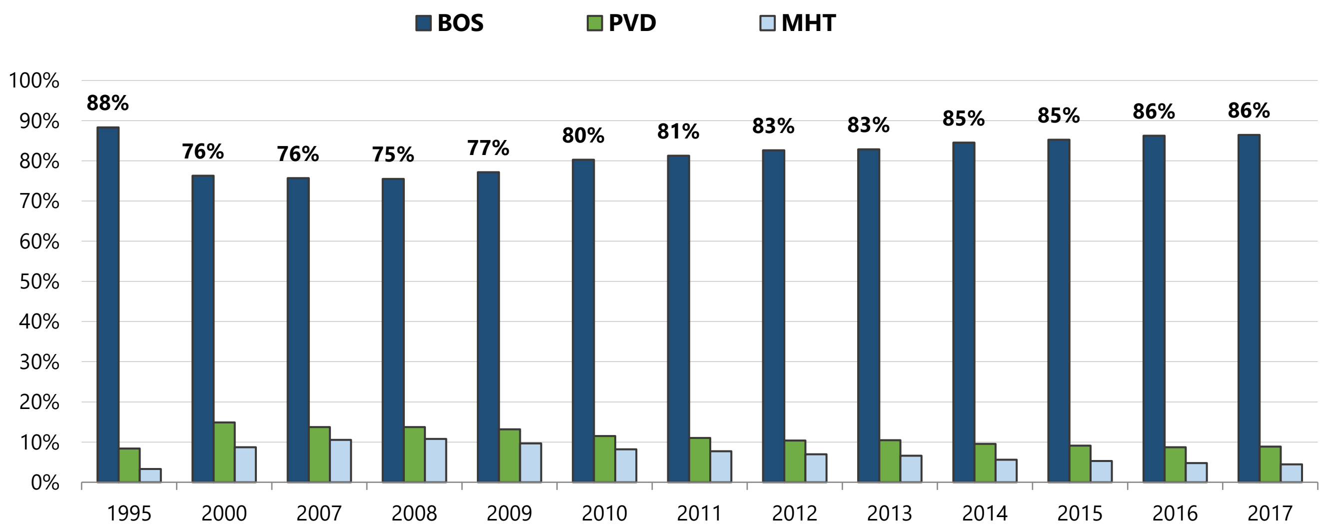


Source: InterVISTAS 2017.

Regional Airport Trends

Historically, changes in air service levels and airfares at the closest regional airports, T.F. Green and Manchester-Boston Regional Airports, have also had an impact on traffic levels at Logan Airport. Over the last 10 years, Logan Airport's share of passengers among the three airports has been consistently increasing. In 2007, Logan Airport accounted for 76 percent of passengers, compared to 87 percent in 2017, an increase of 11 percentage points (**Figure 2-21**).

Figure 2-21 Share of Passengers, Logan Airport (BOS), T.F. Green (PVD), and Manchester-Boston Regional (MHT), 1995, 2000, 2007-2017



Source: InterVISTAS 2017.

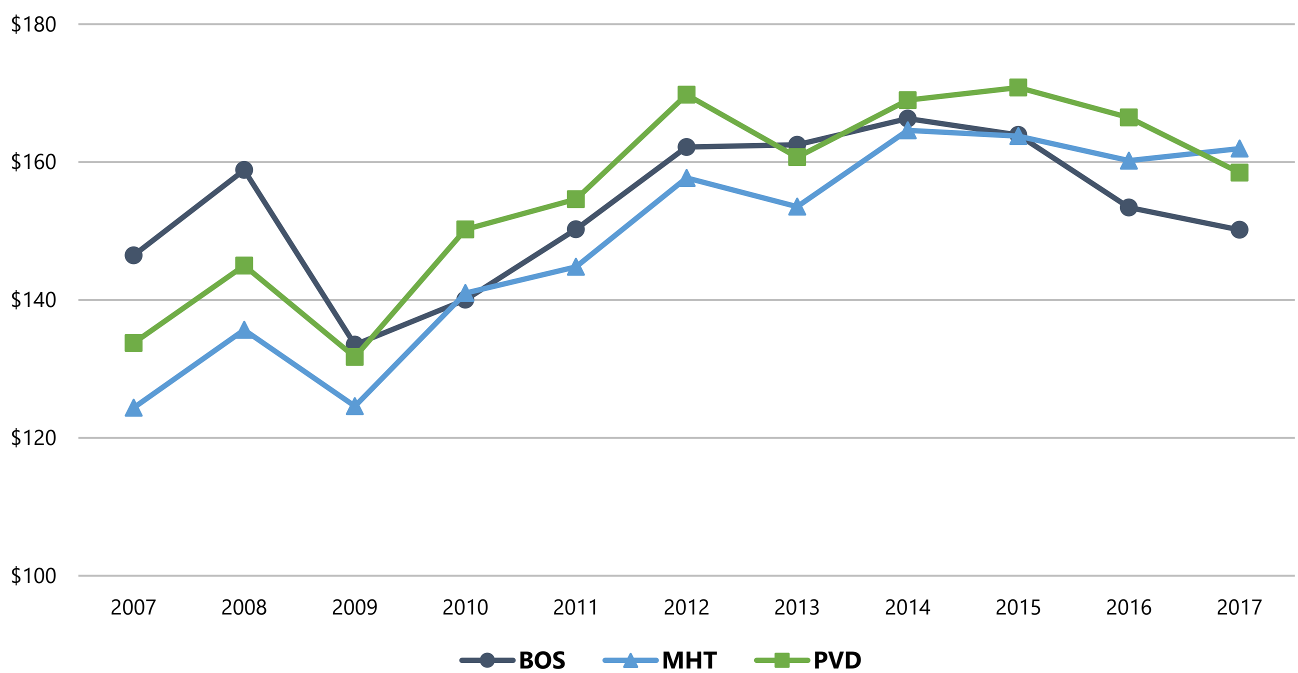
Three factors have led to the dramatic shift in Logan Airport's share of passengers; jetBlue Airways' continued expansion at Logan Airport, the effects of the 2008/2009 recession, and the significant shift in fares in the region resulting in price competitive fares at Logan Airport.

Between 2007 and 2017, jetBlue Airways' average daily non-stop flights from Logan Airport increased from an average of 50 in 2007 to approximately 150 in 2017, while jetBlue's passenger activity levels at Logan Airport increased 183 percent during that same period. Following the increase in fuel prices and the 2008/2009 economic recession, airlines began sharply curtailing services at smaller secondary airports, including T.F. Green and Manchester-Boston Regional Airports. Airlines required higher priced markets, such as Logan Airport at the time, to compensate for the higher cost of fuel. As a result, as jetBlue Airways continued to become a competitive force in the region, Southwest Airlines had no other choice but to enter the Logan Airport market. This greatly altered the pricing environment in the region as Logan Airport became the epicenter for more

affordable airfares in the region. Logan Airport's fares, on average, were higher than Manchester-Boston Regional and T.F. Green Airports until 2009. Starting in 2016, Logan Airport had the lowest fares among the three airports (**Figure 2-22**).

Worcester Regional Airport (ORH) has experienced a resurgence of non-stop service since December 2013, when jetBlue Airways began daily non-stop service to Fort Lauderdale and Orlando. In May 2018, jetBlue Airways added a daily non-stop service to JFK, and American Airlines initiated twice daily non-stop service to Philadelphia (which was reduced to a single daily flight in June 2019). Most recently, Delta Air Lines announced its intention to add a daily non-stop flight to Detroit in August 2019. In 2018, ORH processed nearly 140,000 passengers.

Figure 2-22 Average Domestic Fares at Logan Airport (BOS), Manchester-Boston Regional (MHT), and T.F. Green (PVD), 2007-2017



Source: Inter*VISTAS* 2017.

Updated Logan Airport Planning Forecast

Massport periodically assesses and updates planning forecasts due to global and local economic and market conditions that have a bearing on aviation activity levels. Logan Airport's passenger traffic reached 38.4 million air passengers in 2017 and that growth continued into 2018, with 40.9 million air passengers. This peak follows unprecedented, consistent growth since 2013 at a 6.2 percent annual average growth, making Logan Airport one of the fastest growing airports in the U.S. in terms of passenger activity levels. The seven-year period of growth

since 2010, on which the previous forecast was based, has added almost 11 million new air passengers, equaling a 40-percent increase between 2010 and 2017.

In addition to the national aviation trends described above, since the publication of the *2011 ESPR*, there have been several developments that have affected aviation within the New England region and that have had implications for activity levels at Logan Airport. These include the following:

- Strong economic conditions in Boston including a substantial increase in per capita income compared to the rest of the U.S.
- New international non-stop services led by foreign flag carriers including, but not limited to: Emirates, Qatar Airways, Turkish Airlines, El Al, Cathay Pacific Airways, TAP Air Portugal, Norwegian, and WestJet. These airlines have all entered the Boston market, stimulating local inbound and outbound international passenger demand.
- jetBlue Airways' strategy of forging relationships with the foreign flag carriers in order to facilitate increased connections from jetBlue's Boston network. Markets such as Detroit and Raleigh/Durham connect an increasingly significant number of passengers through Boston onto a diverse group of foreign flag airlines.
- Continued growth by jetBlue Airways and Delta Air Lines. Both carriers have indicated to Massport they will plan to increase the number of departures 10 percent per year at Logan Airport until they reach 200 and 150 daily departures respectively. Southwest Airlines is also expected to expand service in the near future in response to anticipated additional demand.

Passenger Forecast

The region's economic growth is the primary driver of current and future air passenger growth at Logan Airport. As described above, Logan Airport serves the 10th largest metropolitan area in the nation. Residents of the Boston metropolitan area have above average incomes and a high propensity for personal and business-related airline travel. Since no airline maintains a connecting hub operation at the Airport, Logan Airport is principally an O&D airport. Future passenger levels are therefore largely determined by underlying market demand and are not dependent on airlines connecting passengers that transfer from one flight to another. The price of airline travel, which is inversely related to passenger growth, is another factor that affects passenger demand over the long term. Real increases in the price of airline travel (i.e., adjusted for inflation) tend to moderate growth in airport passenger levels. Conversely, price reductions may lead to passenger growth as lower prices entice more people to travel. In the current and foreseeable future operating climate, the price of airline travel is strongly linked to fuel prices.

Rapid technology advances in the aviation sector also have the potential to impact passenger demand and growth. Disruptive technologies affecting the journey to and from the Airport, the ticketing lobby, passenger security, and the experience in the concourse are being developed to improve the passenger experience. Aircraft manufacturers are developing electric and hypersonic aircraft. Biofuels for aircraft are being tested, which will

reduce greenhouse emissions. Autonomous flight continues to be researched. For airlines, replacing pilots with technology could lead to major cost savings; the industry could save as much as $30 billion by adopting autonomous flight technology. The long-term impact of disruptive technology advances on passenger activity are still uncertain, however. Therefore, these technological advances are not factored into the Logan Airport passenger forecast.

The passenger forecasts were prepared using standard industry forecasting techniques analyzing: (1) historical patterns of passenger traffic at the Airport; (2) recent trends at the Airport and in the industry; and (3) the outlook for future aviation demand based on economic factors. More specifically, the long-term forecast was based on over 10 years of historical relationships between the main drivers of air traffic demand at Logan Airport: the economy, airfares, and its local share of regional demand **(Table 2-7)**.

Domestic passenger activity levels are forecast to grow by 1.5 percent annually from 31.1 million in 2017, to 40.8 million in the next 10 to 15 years, while international passengers are forecast to grow by 1.4 percent annually from 7.2 million in 2017 to 9.2 million over the same timeframe (see **Table 2-8**). Average growth rates in the early years of the forecast are higher than for the overall forecast average due to the inclusion of industry knowledge and airline expansion plans. Growth rates level off in the later years as the forecast relies on economic modeling to predict future passenger demand beyond the initial short-term period.

Table 2-7 Passenger Forecast Assumptions

Input[1]	Assumptions Average Annual Growth (through Future Planning Horizon[2])
U.S. Gross Domestic Product (GDP)	2.3%
Regional GDP	2.0%
Regional Total Personal Income	2.2%
Cost of Fuel	1.5%

Source: Inter*VISTAS* 2017 Logan Airport Long-Range Forecast, Woods & Poole.
Notes: Regional defined as the states of MA, RI, and NH.
1 These inputs were updated from the *2011 ESPR*.
2 10- to 15- year timeframe.

Table 2-8 Actual and Forecast Logan Airport Passengers, 2017 and Future Planning Horizon[1]

Passengers	2017	Future Planning Horizon	Average Annual Growth (2017 - Future Planning Horizon)
Scheduled/Charter			
Domestic	**31,100,950**	**40,797,282**	**1.5%**
International	**7,199,595**	**9,202,718**	**1.4%**
Europe/Middle East	4,360,706	6,275,187	2.0%
Canada	1,000,634	1,203,852	1.0%
Bermuda/Caribbean	1,100,769	556,193	(3.7%)
Asia/Pacific	503,386	722,504	2.0%
Central/South America	234,100	444,981	3.6%
Total Scheduled/ Charter	**38,300,545**	**50,000,000**	**1.5%**
General Aviation	111,874	113,905	0.1%
Total Passengers	**38,412,419**	**50,113,905**	**1.5%**

Source: Massport and Inter*VISTAS* 2017 Logan Airport Long-Range Forecast.
1 Represents the 10- to 15-year planning horizon.

In the future, domestic passengers are expected to represent approximately 81 percent of all passengers, similar to the proportion or domestic passengers in 2017. The fastest growing international market segment is Central and South America with a projected 3.6-percent annual growth rate. Asia and the Pacific region are forecast to grow by 2.0 percent, with Europe and the Middle East growing by 2.0 percent, and Canada by 1.0 percent. Europe remains Logan Airport's most mature international market. GA passenger traffic is anticipated to remain relatively stable; it is forecast to grow 0.1 percent annually, increasing from 111,874 in 2017 to approximately 114,000 in the next 10 to 15 years.

Overall, passenger activity levels are expected to increase to approximately 50 million annual air passengers and operations are expected to increase to approximately 486,000 in the next 10 to 15 years (the Future Planning Horizon). In this *2017 ESPR,* the Future Planning Horizon activity level serves as the basis for assessing future environmental impacts of airport operations. This increase in projected passenger levels is consistent with previous ESPR analyses.

Over the past 10 years, the U.S. economy has experienced an unprecedented cycle of growth, which has led to significant airline profits and record-breaking passenger levels at U.S. airports. By most statistical measures, the economy is doing well and has rebounded from the 2008/2009 recession. The economy grew nearly 3 percent in

2018 for the second time since the downturn.[39] Although the current economic expansion is the second-longest in U.S. history, many leading economists are forecasting a recession in the near future.

Logan Airport has consistently been resilient to external shocks and periods of weak demand in the past. With a diversified mix of airlines, a thriving regional economy, and a strong local originating and inbound visitor passenger market, the Airport is well positioned to withstand future external shocks. Furthermore, as mentioned above, increased reliance on additional revenue streams (e.g., co-branded credit cards, baggage, on-board food sales) will help sustain airlines during downturns. These factors can help to limit shocks, not just at Logan Airport, but at airports across the country.

Many aviation studies that incorporate activity forecasts, such as master plans and environmental impact statements, require FAA approval. To gain this approval, the airport sponsor generally must ensure that the forecasts it supplies do not vary significantly from the FAA's Terminal Area Forecast (TAF). The TAF is the official FAA forecast of aviation activity for U.S. airports. The TAF is prepared to assist the FAA in meeting its planning, budgeting, and staffing requirements. In addition, state aviation authorities and other aviation planners use the TAF as a basis for planning airport improvements. The TAF forecasts are made at the individual airport level and are based, in part, on the national FAA Aviation Forecast. The TAF assumes an unconstrained demand for aviation services (i.e., an airport's forecast is developed independent of the ability of the airport and the air traffic control system to supply the capacity required to meet the demand).

The methodologies used to develop the Logan Airport 2017 passenger forecast and the FAA TAF differ slightly. The Logan Airport forecast incorporates short-term service assumptions that are based on direct feedback from the major airlines serving the Airport while also relying on the traditional economic modeling over the longer term. The FAA TAF methodology uses a more standard structure, assuming a demand driven forecast for aviation services based upon local and national economic conditions as well as conditions within the aviation industry.

Although the *2017 ESPR* passenger forecast does not require FAA approval, a comparison to the TAF was developed for reference. Forecasts of passengers and operations are considered consistent with the TAF if they differ by less than 10 percent in the five-year forecast period and 15 percent in the 10-year forecast period. The *2017 ESPR* forecast for passengers at Logan Airport is within 2.5 percent and 4.7 percent at the five and 10-year planning horizons.

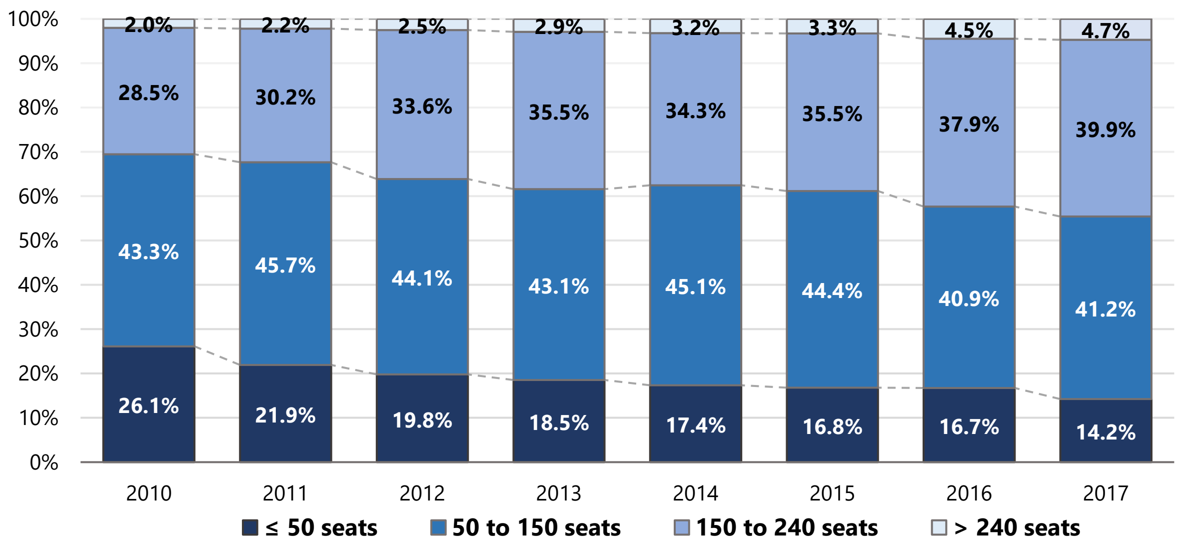
Aircraft Operations and Fleet Mix Forecast

Air passenger numbers increased by 38.5 percent from 2000 to 2017, while aircraft operations have decreased by 17.8 percent, demonstrating more efficient operations. The decline in aircraft operations has resulted from increasing load factors and the introduction of larger aircraft into the market. Between 2010 and 2017, the number of seats per operation increased by over 15, as smaller RJs and turbo-props were replaced with larger narrow-body aircraft (see **Figure 2-23**). The number of aircraft operating with 50 or fewer seats was nearly cut in

39 U.S. Department of Commerce, Bureau of Economic Analysis. 2018. U.S Economy at a Glance Table. https://www.bea.gov/media/3531.

half during this time, as airlines began taking deliveries of larger aircraft in the Boeing 737 and Airbus A320 families as well as the larger two-class RJs.

Figure 2-23 Evolution of Aircraft Fleet Mix at Logan Airport, 2010-2017



Source: Inter*VISTAS* 2017.

Average load factors are forecast to increase for North American, European, and Asian flights to 86.6 percent, 87.6 percent and 89.7 percent, respectively, and to decrease slightly for flights to Latin America by 0.5 percent. Average seats per operation are forecast to increase in all regions with the exception of Europe and the Middle East. Average seats per operation are forecast to increase from about 115 to 125 for North America, from about 254 to 265 for Asia, and from about 146 to 154 for Latin America. European destinations are expected to see more long-range, narrow-body aircraft operations, leading to a decrease in average seats per operation from about 257 to 251 in the future (see **Table 2-9)**.

As shown in **Table 2-10**, Logan Airport's total aircraft operations are forecast to increase slightly at an annual rate of 1.1 percent from 2017 through the Future Planning Horizon. All-cargo aircraft operations are forecast to grow at 0.5 percent annually, however, the largest absolute growth is still expected to come from passenger aircraft operations with jet aircraft operations increasing by 59,901. Passenger jet operations are expected to increase by 1.1 percent per year, RJ operations are forecast to increase by 2.7 percent per year, and non-jet operations are expected to grow 0.1 percent annually. GA operations are forecast to grow by less than 0.1 percent annually between 2017 and the Future Planning Horizon, as there has been a national decrease in personal and hobby flying that is somewhat offset by increasing demand for and popularity of business jets.

RJ operations with aircraft less than 100 seats will continue to increase (e.g., Embraer 175, CRJ-900) as airlines replace smaller, 50-seat, regional aircraft. Non-jet aircraft will remain stagnant as there are no to very limited replacement options for propeller aircraft. Cape Air is expected to continue to operate small propeller aircraft and replace its aging aircraft with similar types of aircraft.

Table 2-9 Average Load Factors and Average Aircraft Size, 2017 and Future Planning Horizon[1]

	Average Load Factors		Average Seats Per Operation	
Region	**2017**	**Future Planning Horizon**	**2017**	**Future Planning Horizon**
North America	85.2%	86.6%	115.1	125.1
Europe/Middle East	79.5%	87.6%	257.0	251.0
Asia	80.9%	89.7%	253.8	265.2
Latin America	86.1%	85.6%	145.7	154.2
Total	**83.2%**	**86.7%**	**124.4**	**134.7**

Source: Inter*VISTAS, U*.S. Department of Transportation T-100 Database.
1 Represents the 10- to 15-year planning horizon.

Table 2-10 Actual and Forecast Logan Airport Operations, 2017 and Future Planning Horizon[1]

Operations	**2017**	**Future Planning Horizon**	**Difference (2017-Future Planning Horizon)**	**Compound Annual Growth (2017-Future Planning Horizon)**
Passenger				
Jet	279,464	339,365	59,901	1.1%
Regional Jet	39,279	62,857	23,578	2.7%
Non-Jet	44,764	45,079	315	0.1%
Subtotal	363,507	447,302	83,795	1.2%
All-Cargo	6,744	7,377	633	0.5%
General Aviation	31,120	31,685	565	0.1%
Total Operations	401,371	486,364	84,993	1.1%

Source: Massport and Inter*VISTAS,* U.S. Department of Transportation T-100 Database.
Notes: Totals may not add exactly due to rounding.
1 Represents the 10- to 15-year planning horizon.

While Logan Airport's passenger levels continue to reach historic highs, aircraft operations in 2017 are well below the historic high in 1998 of 507,000. From 2000 to 2017, the annual number of passengers at Logan Airport increased by 38.5 percent, while the annual number of aircraft operations decreased by 17.8 percent. The declining operations resulted from the accelerated removal of turbo-prop aircraft, the addition of larger aircraft, and increasing load factors. The airlines serving Logan Airport were able to accommodate a greater number of passengers at lower service levels. This trend is expected to continue through the Future Planning Horizon with forecast operations of 486,364. Increasing aircraft capacity and increasing load factors will drive the slower growth in aircraft operations as compared to the passenger growth.

Cargo Forecast

Historically, changes in air cargo activity have mirrored those in gross domestic product (GDP), but declining unit revenues, improved productivity, and globalization of the air cargo industry have also affected the growth in air cargo traffic. Furthermore, the air cargo industry has seen significant structural changes as well. Among these changes are air cargo security regulations issued by the FAA and the Transportation Security Administration (TSA), maturation of the domestic express market, a shift from air to other transport modes (primarily truck), and the growth in international trade from the Open Skies[40] agreements.

Similar to the airline industry, cargo activity at Logan Airport has also undergone significant changes. The unprecedented growth in long-haul international commercial air service has led to an increase in international cargo of 71 percent since 2010. Among the top 10 U.S. airports, Logan Airport was the fastest growing airport for wide-body flights over the past five years. Carried in the aircraft belly compartment, international cargo ("international belly") is a key contributor to the profitability of long-haul international passenger services. International cargo now accounts for approximately 39 percent of Logan Airport's cargo shipments, up from 27 percent in 2010. International cargo is forecast to grow by an annual rate of 1.7 percent through the Future Planning Horizon and represent 43 percent of the Airport's total cargo.

The integrated cargo airlines, dominated by FedEx and UPS, currently account for 92 percent of the domestic cargo market at Logan Airport. The domestic commercial airlines at the Airport have become increasingly less dependent on cargo. In late 2015, jetBlue Airways made a strategic decision not to carry cargo system-wide.

The total volume of cargo at Logan Airport is forecast to increase by 1.1 percent annually from approximately 679 million pounds in 2017 to 829 million pounds in the Future Planning Horizon. International belly is forecast to grow the fastest at 1.7 percent per year as the growth in international wide-body aircraft operations continues.

40 Open Skies Agreements – Since 1992, the U.S. has pursued an "open-skies" policy designed to eliminate government involvement in airline decision-making about routes, capacity, and pricing in international markets. Open Skies agreements have vastly expanded international passenger and cargo flights to and from the U.S., promoting increased travel and trade, enhancing productivity, and spurring high-quality job opportunities and economic growth. The U.S. has reciprocal Open Skies air transport agreements with over 120 partners.

The express all-cargo market is projected to increase by 0.8 percent a year, while the domestic belly market is forecast to decrease by 0.4 percent per year **(Table 2-11).**

Table 2-11 Actual and Forecast Logan Airport Express/Freight (in pounds), 2017 and Future Planning Horizon[1]

Type	**2017**	**Future Planning Horizon**	**Average Annual Growth (2017-Future Planning Horizon)**
Domestic Belly	37,604,311	35,296,758	(0.4%)
International Belly	265,794,588	357,928,053	1.7%
Express All-Cargo	376,009,078	435,326,688	0.8%
Total	679,407,977	828,551,499	1.1%

Source: Massport and Inter*VISTAS* 2017 Logan Long-Range Forecast.
Notes: Numbers in parentheses ( ) indicate negative numbers.
1 Represents the 10- to 15-year planning horizon.

Comparison of Previous and Current ESPR Forecasts

Prior to this *2017 ESPR* forecast, the last activity levels forecast was prepared in 2010 and reported in the *2011 ESPR*. Conditions and trends have changed during that period, now reflected in the updated Future Planning Horizon forecast. **Table 2-12** below compares the *2011 ESPR* planning forecast to the updated *2017 ESPR* planning forecast. The current passenger forecast is higher by approximately 10 million passengers, or 26 percent higher, than the previous *2011 ESPR* planning forecast of 39.8 million passengers. The *2017 ESPR* forecast for aircraft operations (486,364) is approximately 2.5 percent higher than the *2011 ESPR* operations forecast (474,734).

The *2017 ESPR* planning forecast has an average of 103 passengers per aircraft operation compared to 84 passengers per aircraft operation in the previous planning forecast. The increase in average passengers per flight is driven by an increase in average load factors and a shift in the fleet mix towards larger capacity aircraft. The Future Planning Horizon aircraft fleet forecast has a higher percentage of large jet aircraft (100 seats or more) and reflects the next generation of narrow-body jets, which have more seats than older models, as well as the growth in wide-body aircraft operations serving the long-haul international market. Compared to the previous forecast, the *2017 ESPR* planning forecast predicts 2,600 fewer RJs, as the smaller, 50 seat models continue to be removed from network airline fleets. In addition, the non-jet operations are lower by 16,900 from the previous forecast as the network carriers also reduce their turbo-prop operations.

Updates to the Future Planning Horizon forecasts will continue to be based on the most current trends and data available during the next ESPR cycle (approximately five years after this *2017 ESPR*), as necessary.

Table 2-12 Comparison of 2011 ESPR and 2017 ESPR Logan Airport Planning Forecasts

Activity	***2011 ESPR*** **Forecast**	***2017 ESPR*** **Forecast**	**Absolute Difference**	**Percent Difference**
Passengers	39,831,471	50,113,905	10,282,434	25.8%
Operations				
Jet (>100 Seats)[1]	312,727	339,365	26,638	8.5%
Regional Jet (<100 Seats)	65,480	62,857	(2,623)	(4.0%)
Non-Jet	61,982	45,079	(16,903)	(27.3%)
All-Cargo	7,636	7,377	(259)	(3.4%)
GA	26,908	31,685	4,777	17.8%
Total	**474,734**	**486,364**	**11,630**	**2.5%**
Percent of Total Operations				
Jet (≥100 Seats)[2]	65.9%	69.8%	3.9	
Regional Jet (<100 Seats)	13.8%	12.9%	(0.9)	
Non-Jet	13.1%	9.3%	(3.8)	
All-Cargo	1.6%	1.5%	(0.1)	
GA	5.7%	6.5%	0.8	
Total	**100.0%**	**100.0%**		
Passengers per Operation	84	103	19	

Source: Massport, Inter*VISTAS*.
Notes: Numbers in parentheses ( ) indicate negative numbers.
1 *2011 ESPR*.
2 Includes passenger charter operations and regional jets with 100 or more seats.

3

Airport Planning

Key Findings

- The Massachusetts Port Authority (Massport) is continually improving the facilities at Boston Logan International Airport (Logan Airport or the Airport) to accommodate changes in passenger demand, aircraft activity, cargo needs, and transportation access.

- Massport is currently focused on enhancing the passenger and user experience at Logan Airport both on-Airport and by improving accessibility to and from this regional asset.
  - Recent and ongoing terminal area projects, such as the Terminal C to B Connector and the Terminal B Optimization Project, are providing seamless post-security connectivity among the terminals along with enhancements to passenger processing through consolidated security checking areas.
  - To relieve on-Airport roadway congestion and accessibility, Massport plans to implement on-Airport roadway and Massachusetts Bay Transportation Authority (MBTA) Blue Line/intra-terminal connectivity projects and construct consolidated transportation network company (TNC)[1] drop-off and pick-up areas. Massport also has plans to expand high occupancy vehicle (HOV) services and Logan Express facilities as part of a program of ground transportation-related improvements.

- Since the *2016 Environmental Data Report (EDR)* was filed, Massport has submitted two projects for Massachusetts Environmental Policy Act (MEPA) Office review: the Terminal E Modernization Project, which has been approved to add seven new gates to the international terminal, and the Logan Airport Parking Project, which will add 5,000 commercial parking spaces at Logan Airport in locations already in use for parking. The additional parking spaces can be permitted based on a modification to the Logan Airport Parking Freeze[2] and are intended to reduce environmentally harmful drop-off/pick-up modes (i.e., dropped off or picked up by private vehicles, taxi, TNC, or black car limousine service. This project is currently undergoing joint MEPA and National Environmental Policy (NEPA) review.

- Massport continues to work with the Federal Aviation Administration (FAA) to enhance airside safety through a variety of runway safety area (RSA) projects and simplification of the airfield geometry.

1 A transportation network company (TNC) is a company that uses an online-enabled platform to connect paying passengers with drivers who provide transportation from their own non-commercial vehicles. TNCs, including companies such as Uber and Lyft, have emerged as a new option mode of transportation with automobile drop-off and pick-up at Logan Airport terminals. The *2016 Passenger Ground Access Survey* assessed, and future surveys and documents will analyze, trends associated with TNCs.

2 310 Code of Massachusetts Regulations 7.30 and 40 Code of Federal Regulations 52.1120.

Introduction

The increase in the number of air passengers served at Logan Airport can be attributed to the strong local, regional, and national economies. With this growth comes challenges, and Massport has a strategy to address these challenges in a manner that will allow Logan Airport to evolve in a sustainable and environmentally-responsible way. Logan Airport is a key economic and transportation resource in the New England region, the state, and the Boston metropolitan area, which is home to a broad range of industries. In addition to supporting the growth and economic success of the state, Logan Airport and the airport industry are important elements in the state and regional economies.

This chapter describes the status of projects at various stages of planning and development at Logan Airport that support its evolution over time, including updates through the filing date of this report. Specific topics include terminal area projects, service area projects, buffer/open space projects, Airport parking projects, airside area projects, HOV improvements, and Airport-wide projects. The reporting year (2017) was marked by construction of several projects focused on enhancing the passenger experience, accommodating increases in passenger activity levels, and improving ground access. Given the timing of the publication of this *2017 ESPR*, **Table 3-1** presents the status of recent progress on planning initiatives and individual projects at Logan Airport, as well as planned projects and projects under consideration, as of December 31, 2018.

As discussed in Chapter 1, *Introduction/Executive Summary,* of this *2017 Environmental Status and Planning Report (ESPR),* any proposed project that triggers a threshold under MEPA or NEPA will undergo the appropriate project-specific state and/or federal environmental review.

Massport has identified priority planning projects and initiatives to accommodate the increased demand in international and domestic travel including projects and initiatives in the following categories:

- Ground Transportation and Parking;
- Terminals;
- Airside Planning;
- Service Areas;
- Airport Buffers and Open Space; and
- Energy, Sustainability, and Resiliency.

Ground Transportation and Parking

Massport recognizes the challenges Logan Airport is currently facing on its roadways and access to and from the Airport, which are priority planning interests. To address these challenges, Massport is focusing on HOV investment, TNC management, parking management, and on-Airport roadway congestion relief.

Massport's strategies to improve and expand HOV service to and from Logan Airport include continued investment in Logan Express facilities and service. Massport has a goal to double Logan Express ridership from 2 million to 4 million passengers, thereby reducing vehicle miles traveled (VMT), congestion, and air quality emissions. Initiatives are underway at the urban and suburban Logan Express sites, including increasing frequencies, evaluating new sites, adding parking spaces, adding amenities, and reducing fares.

In 2018, more than a quarter of on-Airport traffic was from activities related to TNC activity which contributed to unprecedented congestion on Airport roadways. In an effort to reduce congestion, emissions, and TNC deadhead[3] activity, Massport is relocating most TNC drop-off/pick-up activity to the ground floor of the Central Parking Garage complex, with the exception of drop-off at terminal curbs during the 4:00 AM to 10:00 AM peak departure period. This area will provide weather-protected, climate-controlled areas for passengers, including wheelchair assistance, curb-side baggage check, and other amenities. Massport is also identifying specific curbside locations at each terminal for drop-off/pick-up to provide convenient accommodations for persons with disabilities.

Massport's parking management strategy addresses parking supply, pricing, and operations to promote the use of HOV, transit, and shared-ride options and to reduce environmentally harmful drop-off/pick-up modes. In accordance with the approvals by the Massachusetts Department of Environmental Protection (MassDEP) and the U.S. Environmental Protection Agency (EPA) to modify the Logan Airport Parking Freeze, Massport has proposed to build an additional 5,000 commercial parking spaces at Logan Airport in a new garage in front of Terminal E and by expanding the Economy Garage. Each proposed garage will be designed in accordance with Massport's Sustainable Design Standards and Guidelines and incorporate measures from the U.S. Green Building Council's sustainability-focused Parksmart rating system.[4] As part of modifying the Logan Airport Parking Freeze, Massport has also committed to advancing three key Logan Airport ground access studies. The findings of these studies will be reported in the next EDR. These studies analyze the feasibility and effectiveness of the following:

- Potential services and improvements to HOV access;
- Potential operational measures to further reduce drop-off/pick-up modes; and
- Possible pricing strategies for different modes.

Projects that aim to provide on-Airport roadway congestion relief include on-Airport roadway improvements to enhance efficiency and reduce congestion; roadway and curb improvements in front of Terminal C (Arrival and Departure levels) to reduce peak hour congestion and prioritize HOV access; and improvements to the roadways connecting Terminals B and C to improve circulation, reduce congestion, and improve safety. Construction is ongoing as of this filing and expected to be complete by October 2022.

Terminals

Massport recently completed the Terminal B Optimization Project, which upgraded the security checkpoints and added substantial passenger amenities primarily for American Airlines and Air Canada. Enhanced post-security connections between Terminals B and C are under construction to optimize passenger movements and security. Other enhancements include expanded passenger amenities for current and future passenger needs. Massport is also planning improvements to Terminal A, including interior upgrades in the main terminal and satellite terminal, enhanced passenger amenities, reconfiguration and improvements at the security checkpoint, and a feasibility study of post-security connection between Terminal A and Terminal B, and Terminal A and Terminal E.

3 Deadhead trips are those trips to or from the Airport that do not contain a passenger.
4 U.S. Green Building Council's Parksmart Certification Standard. https://www.usgbc.org/resources/parksmart-certification-standard.

In conjunction with the ongoing design and planning construction of the Terminal E Modernization Project, which will add seven gates[5] to the international terminal, Massport is studying alternatives for connecting the MBTA Blue Line and the terminal area. Additionally, over 170,000 square feet of impervious surface is being converted to new green space along Terminal E for a total of 190,000 square feet of green space in that area.

Airside Planning

Massport continues to upgrade and improve the airfield to enhance the operational efficiency and safety of Logan Airport while exploring ways of efficiently using the limited land resources in the service areas. In coordination with the FAA, Massport recently completed a comprehensive multi-year Runway Incursion[6] Mitigation Study and Comprehensive Airfield Geometry Analysis (RIM, or RIM Study) to identify, prioritize, and develop strategies to help Massport mitigate risk.[7] Massport is also currently working with the FAA to explore options to enhance the RSA of Runway 27.

Service Area Planning

Massport is continually undertaking service area improvements to maximize efficient use of limited land resources and respond to the changing needs of airline businesses, customers, and tenants. Among several planned improvements, Massport is currently exploring options to improve the layout of the North Service Area (NSA) by reorganizing the existing uses to enhance safety and improve efficiency of activities within the runway protection zone (RPZ). In addition, Massport is considering construction of additional jet fuel storage facilities in the NSA, adjacent to the existing jet fuel storage tanks.

Airport Buffers and Open Space

Massport has invested in an extensive open space program to enhance the surrounding communities. Massport initially committed over $15 million for the planning, construction, and maintenance of four Airport edge buffer areas and two parks along Logan Airport's perimeter. These buffers include the Bayswater Embankment Airport Edge Buffer, Navy Fuel Pier Airport Edge Buffer, Neptune Road Airport Edge Buffer, and the Southwest Service Area (SWSA) Airport Edge Buffer (Phases I and II). The award-winning Piers Park was completed in 1995 and has since become part of a network of greenspace that traverses East Boston from the Jeffries Point waterfront to Constitution Beach.

Adjacent to the current Piers Park, Piers Park Phase II will add approximately 4.2 acres of green space to the East Boston waterfront upon completion. Studies are also underway by an outside party for a potential Piers Park Phase III, which would turn an aging pier into a 3.6-acre greenspace including resiliency features to help protect the neighborhood from flooding and sea level rise. Today, East Boston enjoys 3.3 miles and more than 33 acres of green space developed or managed by Massport, in partnership with and in response to engagement with the East Boston community.

5 The Terminal E Modernization Project will add the three gates approved in 1996 as part of the International Gateway West Concourse project (EEA # 9791), but never constructed, and add an additional four gates.

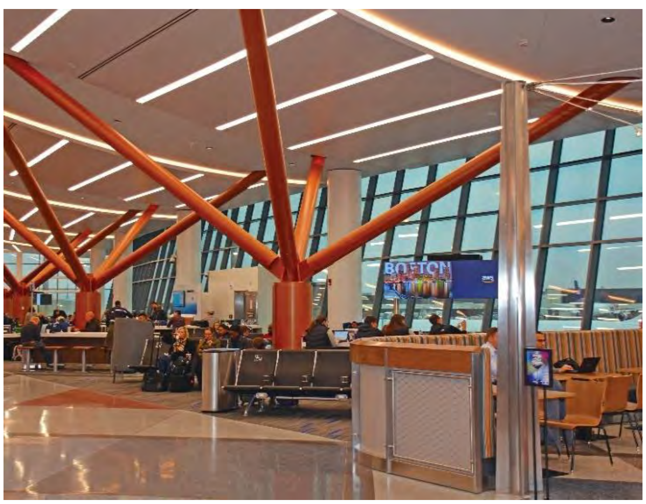
6 Runway incursions occur when an aircraft, vehicle, or person enters the Airport's designated area for aircraft landings and take-offs.

7 Information on FAA's RIM program can be found at https://www.faa.gov/airports/special_programs/rim/.

Energy, Sustainability, and Resiliency Planning

Massport is continuing to incorporate sustainability considerations into its projects and is currently working on a vision for Massport "Sustainability 2.0." The vision for this next-level planning effort is to implement principles and approaches from the Logan Airport Sustainability Management Plan (SMP) at other Massport facilities and to update Massport's sustainability goals and targets. Massport is also focused on the following:

- Massport is facilitating the replacement of gas- and diesel-powered ground service equipment (GSE) with all-electric GSE (eGSE) by the end of 2027 (as commercially available).
- Massport is studying opportunities to maximize solar installations across Logan Airport and is installing electric vehicle infrastructure on the airside and in the parking garages.
- In 2018, the EPA awarded a $541,817 grant to Massport to replace gas- and diesel-powered GSE at Logan Airport. This grant will be used in conjunction with an FAA Voluntary Airport Low Emissions Program (VALE) grant that Massport received in Fall 2018 to install eGSE charging stations as part of the Terminal B Optimization Project.
- Massport has a robust effort underway that has identified vulnerabilities from climate and other natural threats on the Airport and is now incorporating resilient infrastructure design standards for existing and future flood levels for all types of Airport projects.



Source: Massport.
Note: Left photo is Logan Airport's Terminal B Optimization Project, which incorporates energy saving measures with View Dynamic Glass.
Right photo displays new high-efficiency natural gas systems in South Cargo Area buildings.

Table 3-1 Logan Airport Short- and Long-Term Planning Initiatives

		Completion	
		Short-Term	**Long-Term**
	Status as of Dec. 31, 2018	**By End of 2025**	**By End of 2035**
Airport Ground Transportation and Parking Projects/Planning Concepts			
West Garage Parking Consolidation Project	Complete (2016)		
Logan Airport Parking Project (additional 5,000 spaces)	Permitting	✈	
Logan Airport Parking Project: Parking Freeze Studies	Planning	✈	
On-Airport Roadway Congestion Relief Infrastructure	Feasibility/ Planning		✈
Transportation Network Company (TNC) Infrastructure and Policy	Planning	✈	
Logan Express Route and Facility Expansion (Off-Airport)	Planning	✈	
Terminal Area Projects/Planning Concepts			
Terminal E Renovations and Enhancements	Complete (2017)		
Terminal E Modernization	Design	✈	
Convenience and Filling Station/ Taxi Pool/TNC Lot Relocations	Construction	✈	
Terminal B Optimization	Construction	✈	
Terminal C to E Airside Connector	Complete (2016)		
Terminal C, Pier B Optimization	Design	✈	
Terminal C Canopy, Connector, and Roadway Project	Design	✈	
Terminal A to B Landside Connector	Complete (2016)		
Terminal A to B Airside Connector	Feasibility/ Planning		✈
Terminal A Improvements	Feasibility		✈
Airside Projects/Planning Concepts			
Runway 15L-33R Runway Safety Area (RSA) Improvement	Complete (2014)		
Runway 4R Light Pier Replacement	Complete (2017)		
Runways 22R and 33L RSA Improvements/Runway 33L Light Pier Replacement	Complete (2014)		
Runway 9-27 RSA Improvement Project	Feasibility/ Planning	✈	
Runway Incursion Mitigation (RIM) Study and Comprehensive Airfield Geometry Analysis	Complete (2019)		

Table 3-1 Logan Airport Short- and Long-Term Planning Initiatives (Continued)

		Completion	
		Short-Term	Long-Term
	Status as of Dec. 31, 2018	By End of 2025	By End of 2035
Service Area Projects/Planning Concepts			
Southwest Service Area (SWSA) Redevelopment Program (Rental Car Center)	Complete (2014)		
North Service Area (NSA) Runway Protection Zone (RPZ) Enhancements	Feasibility/ Planning	✈	
Jet Fuel Storage Addition – NSA	Feasibility/ Design	✈	
Group 1 Hangar – South Cargo Area	Feasibility/ Planning	✈	
Governors Island Equipment Storage	Feasibility		✈
Replacement Hangar	Feasibility/ Planning		✈
Relocated Compressed Natural Gas (CNG) Station – North Cargo Area (NCA)	Feasibility/ Planning		✈
Replacement Cargo Facilities – NCA	Feasibility	✈	
New/Replacement Snow Removal Equipment (SRE) and Ground Service Equipment (GSE) Building – NCA	Feasibility/ Planning	✈	
Joint Operations Center (JOC)	Feasibility/ Planning		✈
Airport Buffers/Open Space Projects			
SWSA Airport Edge Buffer (Phases I and II)	Complete (2014)		
Neptune Road Airport Edge Buffer	Complete (2016)		
Navy Fuel Pier Airport Edge Buffer	Complete (2007)		
Bayswater Embankment Airport Edge Buffer	Complete (2003)		
Bremen Street Park and Dog Park	Complete (2016)		
Greenway Connector	Complete (2014)		
Community Greenway Enhancements	Complete (2015)		
Narrow-Gauge Connector	Complete (2016)		
Piers Park Phase I	Complete (1995)		
Piers Park Phase II	Design	✈	
Piers Park Phase III (*by others*)	Feasibility		✈
Energy, Resiliency, and Sustainability Planning			
Energy Planning	Ongoing	✈	✈
Electric Ground Service Equipment (eGSE) installation	Ongoing	✈	✈
Resiliency Planning	Ongoing	✈	✈
Sustainability Planning	Ongoing	✈	✈

Notes: Anticipated completion dates and status as of December 31, 2018, as denoted by ✈.
Short-term projects are anticipated to be completed by 2025 and long-term projects are anticipated to be completed by 2035.
Details of each project or planning concept are provided in the sections that follow.

Airport Ground Transportation and Parking Projects/Planning Concepts

Massport continues to implement an evolving ground transportation strategy, which includes ongoing operational and capital commitments to the Logan Express services, the MBTA Silver Line 1 (SL1) service, and MBTA Blue Line station shuttles, as well as continued partnership with and marketing of private bus carriers.

HOV Investment

Massport is currently evaluating a number of projects and strategies to improve and expand HOV service to and from Logan Airport, which include continued investment in Logan Express facilities and service. Massport has a goal to double Logan Express ridership from 2 million to 4 million passengers, thereby reducing VMT, congestion, and air quality emissions by shifting riders from other vehicle modes. At suburban locations, Massport proposes the following action plan:

- Increase Braintree Logan Express service from two to three trips per hour (implemented in 2019);
- Add additional 1,000 spaces to the Framingham garage;
- Build up to 3,000 structured parking spaces at the Braintree site that is nearing capacity;
- Provide security line priority status for Logan Express Back Bay (implemented in 2019);
- Execute sustained marketing campaign to support Logan Express strategy and increase ridership;
- Implement Logan Express electronic ticketing;
- Evaluate new Logan Express suburban locations, with a plan to open at least one new site.
- Explore TNC Last Mile connections;[8]
- Rebrand Logan Express sites as remote terminals; and
- Continue to monitor parking capacity at all Logan Express sites.

The Back Bay Logan Express operates daily between the hours of 5:00 AM and 10:00 PM. One-way fares in 2017 were $7.50 per passenger. Riders with a current, valid MBTA pass received a reduced $3 fare. Massport has recently implemented a number of improvements to the service with a focus on boosting urban Logan Express ridership and is considering the following additional services for the near future:

- Change pick-up/drop-off location from Copley to Back Bay Station (implemented in 2019);
- Discount one-way fare from $7.50 to $3.00 (implemented in 2019);
- Free service from Logan Airport (implemented in early 2019);
- Pilot priority security line status for riders (implemented in 2019);
- Execute marketing campaign to support increased ridership (ongoing);
- Implement Logan Express electronic ticketing; and
- Implement a second urban Logan Express service at North Station.

8 Individuals who fall within the 0.5-mile to 1-mile drive distance of a Logan Express facility are the most likely group to use TNCs to connect between the facility and their home.

Eight Silver Line buses, connecting the Airport to South Station, are paid for by Massport and operated by the MBTA. In 2017, Massport funded mid-life rebuilds of four Silver Line buses and rebuilt four additional buses in 2018. The mid-life rebuild extends the useful life of each vehicle by approximately eight years. This will allow the MBTA to maintain reliability and quality of operations along the Silver Line today while initiating the procurement process to acquire new vehicles in the future. Massport plans to purchase eight additional Silver Line buses, bringing its total to 16 buses, to increase frequency and improve service. Chapter 5, *Ground Access to and from Logan Airport,* provides additional information on these efforts.

In future air passenger ground access surveys, Massport will use an updated HOV definition where vehicle occupancies of taxis, black car limousines, and TNCs that exceed one air passenger per vehicle will be considered HOV, while the same modes with one air passenger will count as non-HOV. With this updated definition, Massport has committed to a goal of 35.5 percent HOV under the new definition by 2022 and 40 percent HOV by 2027.

Progress towards Massport's HOV goal is measured using the triennial air passenger ground-access survey. The latest published survey, conducted in 2016, revealed an air passenger ground access mode share of 30.5 percent for HOV and shared-ride modes. This value increased 2.7 percent compared to 2013 and is roughly the same as the survey indicated in 2010.

Parking Management

Massport continues to manage parking supply, pricing, and operations to promote the use of HOV, transit, and shared-ride options and to reduce drop-off/pick-up modes. As air traveler numbers have increased, the legally constrained parking supply at Logan Airport, resulting from the Logan Airport Parking Freeze, has periodically had the unintended consequence of causing an increase in environmentally harmful drop-off/pick-up vehicle trips. The goal of the Logan Airport Parking Project is to reduce the use of drop-off/pick-up modes, which generate up to four vehicle trips instead of two (**Figure 3-1**). While the intent of the Logan Airport Parking Freeze has been to shift air passengers to HOV travel modes with lower VMT, survey data collected from the 1970s to the present at Logan Airport have consistently shown that if parking was not an option for passengers who parked on-Airport, 77 percent of diverted parkers would use drop-off/pick-up modes-generating a higher level of VMT and associated air emissions (**Figure 3-1**).

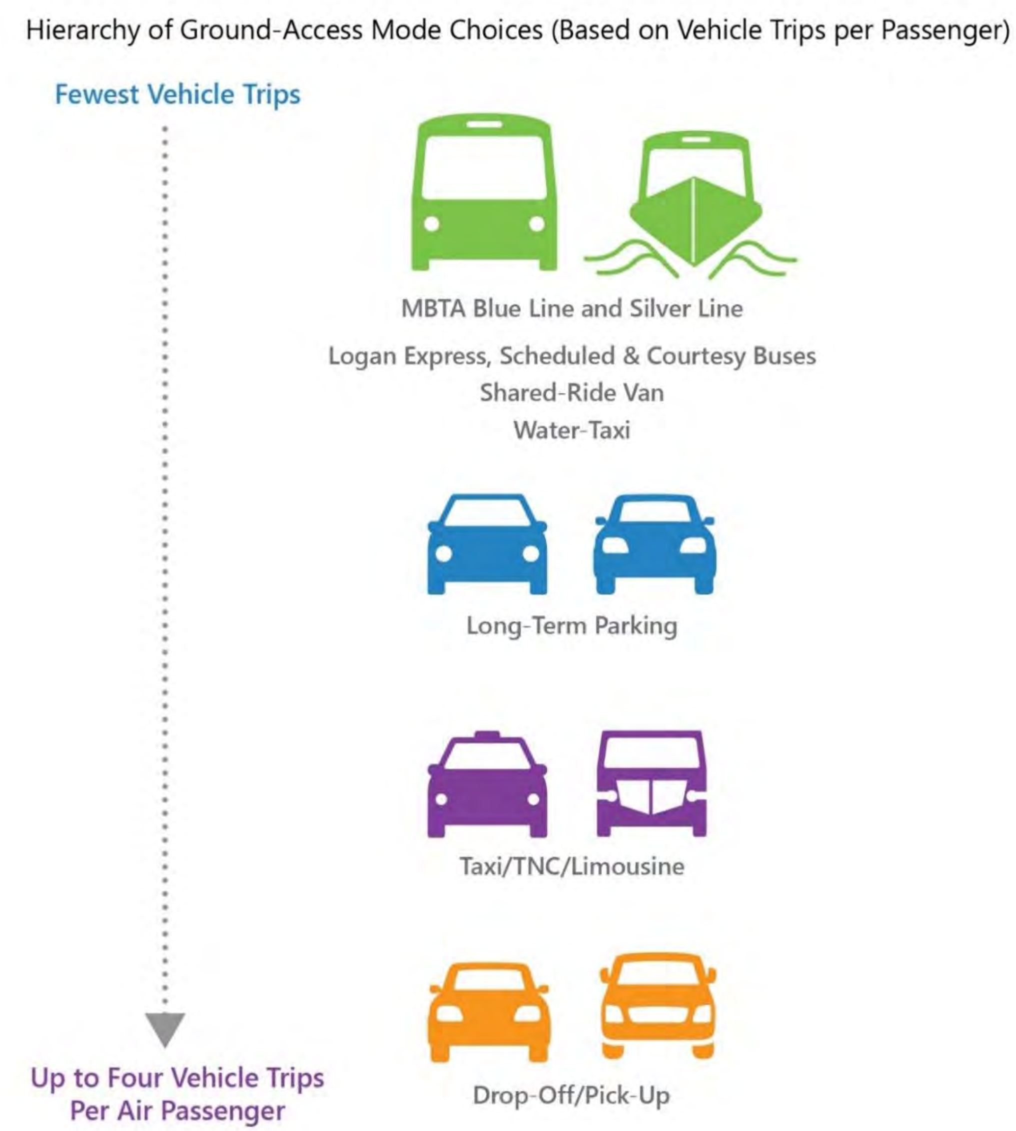
In 2017, the Logan Airport Parking Freeze regulation was revised to allow for an increase of 5,000 on-Airport commercial parking spaces to alleviate constrained parking conditions on-Airport. Until the recent amendments to the Logan Airport Parking Freeze, the total number of employee and commercial parking spaces permitted at Logan Airport was limited to 21,088 spaces under the State Implementation Plan (SIP) and MassDEP air quality regulations; the amendment has increased the limit to 26,088 spaces (there was no increase in the number of employee parking spaces).

Massport has proposed phased construction of 5,000 new on-Airport commercial parking spaces at Logan Airport in compliance with the amended Logan Airport Parking Freeze, including 2,000 spaces in a new garage at the existing surface parking lot in front of Terminal E and an expansion of the Economy Garage with an addition of 3,000 spaces. **Figure 3-2** shows the proposed sites for new parking garage facilities.

Table 3-2 provides details on the Environmental Impact Report (EIR)/Environmental Assessment (EA) process in addition to describing other current commercial parking projects at Logan Airport.

In accordance with the modified Logan Airport Parking Freeze approved by MassDEP and the EPA, to allow for an additional 5,000 commercial parking spaces at Logan Airport, Massport has taken steps to advance three key Logan Airport ground access studies, also known as the Logan Airport Parking Freeze Amendment Ground Access and Trip Reduction Strategy Studies. The findings of these studies will be reported in the next EDR.

Figure 3-1 Ground-Access Mode Choice Hierarchy



Source: VHB.
Notes: Short-term parking is included under "drop-off/pick-up."
Rental cars are included in the number of Parked Vehicles.

FIGURE 3-2 Location of Airport Ground Access Projects/Planning Concepts

2017 Environmental Status and Planning Report

Notes: See Table 3-2 for a description of the numbered projects. Status as of December 31, 2018.

1. West Garage Parking Consolidation (complete)

2a. Logan Airport Parking Project - Economy Garage

2b. Logan Airport Parking Project - Terminal E Surface Lot

Airport-Wide or Location To Be Determined

3. Logan Airport Parking Project: Parking Freeze Studies
4. On-Airport Roadway Congestion Relief Infrastructure
5. Transportation Network Company (TNC) Infrastructure and Policy
6. Logan Express Route and Facility Expansion (Off-Airport)

0 500 1000 2000 Feet

Table 3-2 Description and Status of Airport Ground Access Projects/Planning Concepts (December 31, 2018)

Description	Status
1. West Garage Parking Consolidation Project	
Massport consolidated 2,050 temporary parking spaces as an addition to the West Garage and at the existing surface lot between the Logan Office Center and the Harborside Hyatt. The project incorporated sustainable design and resiliency elements.	On March 20, 2014, the Executive Office of Energy and Environmental Affairs (EEA) issued an Advisory Opinion confirming no review of the Massachusetts Environmental Policy Act (MEPA) was required for the consolidation of existing on-Airport parking spaces. The consolidation project was completed in late 2016.
2. Logan Airport Parking Project (additional 5,000 spaces)	
As one element of its comprehensive transportation strategy, Massport has proposed the phased construction of 5,000 new on-Airport commercial parking spaces at Logan Airport in two locations. This project would include construction of a 2,000-space structured garage in the parking lot in front of Terminal E and a 3,000-space addition to the Economy Garage. Each of the proposed garages will be designed in accordance with Massport's Sustainable Design Standards and Guidelines and incorporate measures from the U.S. Green Building Council's Parksmart rating system, an environmental and sustainability focused rating system specific to parking structure management, programming, design, and technology.	In response to Massport's 2016 request to consider an amendment to the Logan Airport Parking Freeze (to increase the commercial parking freeze limit by 5,000 spaces), the Massachusetts Department of Environmental Protection (MassDEP) conducted a stakeholder process, followed by a public process to amend the Logan Airport Parking Freeze regulation. MassDEP issued the amended regulation on June 30, 2017 approving the requested parking increase. On December 5, 2017, the U.S. Environmental Protection Agency (EPA) proposed a rule approving the revision of the Massachusetts State Implementation Plan (SIP) incorporating the amended Logan Airport Parking Freeze. The final rule was issued on March 6, 2018 and became effective on April 5, 2018. Massport initiated a parallel process with EEA by filing an Environmental Notification Form (ENF) for new parking facilities on March 31, 2017. A Secretary's Certificate on the ENF was issued on May 5, 2017 establishing the scope for the required Draft Environmental Impact Report (EIR). The Draft EIR/Environmental Assessment (EA) was published in May 2019 and provides additional details on the number of spaces per location and planned construction phasing.
3. Logan Airport Parking Project: Parking Freeze Studies (Airport-wide)	
In accordance with the June 2017 approval by MassDEP and the April 2018 approval by the EPA to modify the Logan Airport Parking Freeze to allow for an additional 5,000 commercial parking spaces, Massport has taken steps to advance three key ground access studies. These include analyzing the feasibility and effectiveness of the following: ▪ Potential services and improvements to high occupancy vehicle (HOV) access; ▪ Possible pricing strategies for different modes; and ▪ Potential operational measures to further reduce drop-off/pick-up modes.	These studies will be reported on in the next Environmental Data Report (EDR).

Table 3-2 Description and Status of Airport Ground Access Projects/Planning Concepts (December 31, 2018) (Continued)

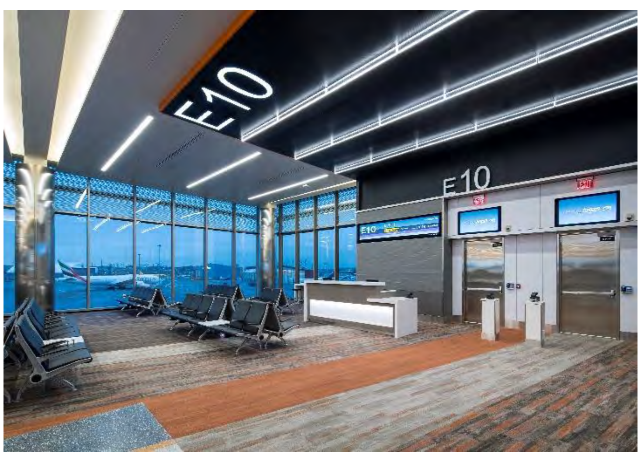
Description	Status
4. On-Airport Roadway Congestion Relief Infrastructure (locations to be determined)	
In addition to the planned roadway improvements as part of the Terminal C Building, Roadway, and Curb Enhancements, Terminal E Modernization, and Logan Airport Parking Projects, Massport is considering other possible infrastructure modifications to complement the roadway changes mentioned above, as well as policy changes to allow terminal area roadways and curbsides to continue functioning adequately and minimize vehicle idling time and associated emissions. Several options are being considered to reduce on-Airport congestion and improve on-Airport ground access efficiency, including dedicated HOV bus lanes, the creation of an intermodal transportation center with bus service to terminals, the construction of an Automated People Mover (APM), or some combination of these improvements. It is envisioned that these changes will allow Massport to reduce vehicle miles traveled (VMT) despite increasing passenger activity levels.	As planning evolves, the infrastructure and management options for improving ground access efficiency at Logan Airport will be evaluated and will be further documented in subsequent environmental filings and EDRs. National Environmental Policy Act (NEPA) and MEPA processes will occur, if required.
5. Transportation Network Company (TNC) Infrastructure and Policy (Airport-wide)	
Massport began tracking and reporting TNC (such as Uber and Lyft) activity in 2017. TNCs are estimated to contribute approximately 15,000 vehicle trips per day (excluding deadhead trips). TNC operations are adversely impacting other modes to the Airport and contributing to on-Airport congestion. As TNCs have become an increasingly popular option for travelers going to and from Logan Airport, Massport has and will continue to develop strategies to facilitate efficient operation of all modes of ground transportation. In an effort to reduce congestion and emissions, Massport has a robust plan to manage TNC operations and reduce TNC deadhead activity. Massport's plan includes a rematch and shared ride program, TNC fee structure changes to encourage shared rides and competition between modes, and optimization of TNC operations on-Airport. Additional details can be found in Chapter 5, *Ground Access to and from Logan Airport*.	Massport is currently planning a consolidation of TNC activities for the ground floor of the Central and West Garages, with implementation later in 2019. Other pricing and policy changes are under study.
6. Logan Express Route and Facility Expansion (Off-Airport)	
To maximize Logan Airport's off-campus traffic and infrastructure improvements, Massport has a goal to double Logan Express ridership from 2 million to 4 million passengers, thereby reducing VMT, congestion, and air quality emissions by shifting riders from other vehicle modes. Investments being considered for Logan Express include improving Back Bay Logan Express service, offering a new urban Logan Express service at North Station, pursuing new suburban Logan Express locations, increasing the frequency of the Braintree service, investing in existing suburban sites, and investing in structured parking at existing sites, among others. Additional details can be found in Chapter 5, *Ground Access to and from Logan Airport*.	Some initiatives to expand Logan Express routes and facilities have already commenced, (e.g., studies to improve ridership, expansion of services, and evaluation of new suburban Logan Express locations). Other concepts are currently under evaluation and will be implemented within the next 10 years.

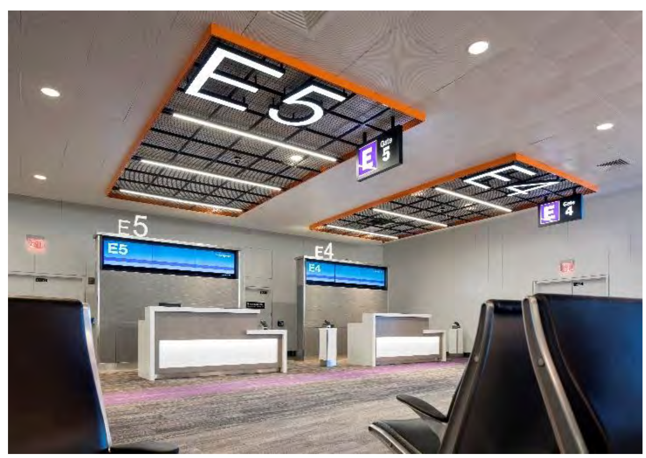
Source: Massport.
Notes: See **Figure 3-2** for the location of Airport parking projects/planning concepts.

Terminal Area Projects/Planning Concepts

The terminal area accommodates most of the passenger functions at Logan Airport, including the passenger terminals, terminal-area roadways, central parking facilities, and the Hilton Hotel. **Table 3-3** presents information on the status of each ongoing terminal area project. In addition, both Massport and its tenants are proposing projects or exploring planning concepts to modernize and carry out future improvements to the existing terminal facilities. The location of the ongoing terminal area projects and the planning concepts are shown on **Figure 3-3**.


Terminal B Optimization Project.
Source: Massport.





Terminal E Renovation and Enhancements Project.
Source: Massport.

FIGURE 3-3 **Location of Projects/Planning Concepts in the Terminal Area**

2017 Environmental Status and Planning Report

Notes: See Table 3-3 for a description of the numbered projects. Status as of December 31, 2018.

1. Terminal E Renovation and Enhancements (complete)
2. Terminal E Modernization
3a. Relocated Convenience and Filling Station
3b. Relocated Taxi Pool Lot
3c. Relocated TNC Lot
4. Terminal B Optimization
5. Terminal C to E Airside Connector (complete)
6. Terminal C, Pier B Optimization
7. Terminal C Canopy, Connector, and Roadway Project
8. Terminal A to B Landside Connector (complete)
9. Terminal A to B Airside Connector
10. Terminal A Improvements

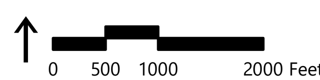


Table 3-3 Description and Status of Projects/Planning Concepts in the Terminal Area (December 31, 2018)

Description	Status
Massport Projects/Planning Concepts	
1. Terminal E Renovation and Enhancements	
This project included interior and exterior improvements at Terminal E to accommodate regular service by wider and longer Group VI aircraft. The project did not include any new gates but did include the reconfiguration of three existing gates to accommodate Group VI aircraft (including the A380 and B747-8 used by international air carriers). Some runway and taxiway shoulders were upgraded to support more frequent Group VI activity.	Planning was initiated in 2014. A federal Environmental Assessment (EA) was filed in July 2016, and the Federal Aviation Administration (FAA) issued a Finding of No Significant Impact (FONSI) on July 29, 2016. Project construction was completed in early 2017.
2. Terminal E Modernization (incorporates former West Concourse Project)	
The Terminal E Modernization Project will add the three gates approved in 1996 as part of the International Gateway West Concourse project (EEA # 9791), but never constructed, and add an additional four gates. The building will be aligned to function as a noise barrier. New passenger handling and passenger holdrooms are being planned, as well as possible additional Federal Inspection Services (FIS) and Customs and Border Protection facilities to supplement the existing FIS areas in Terminal E. The Terminal E Modernization Project will occupy a portion of the North Cargo Area (NCA) and will include terminal gates, aircraft parking, hangars, and cargo facilities. The existing UPS cargo building will be relocated. Upon completion of this project and following a broader ground transportation strategy and planning process, a covered pedestrian connection between Terminal E and the Massachusetts Bay Transportation Authority (MBTA) Blue Line Airport Station will be constructed to improve passenger convenience. This connection is currently being studied and various approaches are under consideration.	An Environmental Notification Form (ENF) was filed with the Executive Office of Energy and Environmental Affairs (EEA) in October 2015. A joint draft federal Environmental Assessment (EA)/state Environmental Impact Report (EIR) was filed in July 2016 in accordance with the National Environmental Policy Act (NEPA) as well as the Massachusetts Environmental Policy Act (MEPA). Massport filed the Final EA/EIR on September 30, 2016. FAA issued a FONSI on November 10, 2016, and a Record of Decision (ROD) on the project on November 14, 2016, stating that Massport can update the Airport Layout Plan (ALP) with the Terminal E Modernization Project. (For convenience, Massport has provided the Secretary's Certificates on the ENF and Draft EA/EIR, with responses to those comments, in Appendix A, *MEPA Certificates and Responses to Comments,* of this *2017 Environmental Status and Planning Report [ESPR].*) The project, including the MBTA connection, is in the design phase. Initial construction began in 2019. Future Environmental Data Reports (EDRs) will provide updates as final design and construction proceed. The infrastructure options for connecting the MBTA Blue Line and the terminals are currently being evaluated and will be further documented in subsequent environmental filings and EDRs.

Table 3-3 Description and Status of Projects/Planning Concepts in the Terminal Area (December 31, 2018) (Continued)

Description	Status
Massport Projects/Planning Concepts	
3. Convenience and Filling Station/Taxi Pool/TNC Lot Relocations	
Construction of the Terminal E Modernization Project includes the relocation of the existing on-Airport gas station to the intersection of Tomahawk Drive and Jeffries Street on Massport property (Southwest Service Area). With input from the community-based Logan Impact Advisory Group, this location provides community benefits such as convenience stores for local vendors (Starbucks and Meridian Food Market), and landscaping and beautification enhancements. Another part of the design phase involved Massport further evaluating transportation and land-uses in this area in an effort to reduce vehicular congestion along Tomahawk Drive associated with the growing Transportation Network Company (TNC) mode. As a result, it was determined that the TNC Pool Lot would be relocated to the existing taxi pool at Porter Street because this would minimize Tomahawk Drive traffic and congestion. Similarly, the existing taxi pool lot will be returned to the Blue Lot between the Logan Office Center and the Hyatt Hotel. By relocating the TNC pool, greater operational flexibility and additional routing options are available that will allow Massport to reduce TNC impacts along Tomahawk Drive (shown as 3a, 3b, and 3c in **Figure 3-3**).	The replacement gas station was approved as part of the Terminal E Modernization Project's MEPA and NEPA review process described above. Construction is underway and is estimated to be complete in 2019. Massport relocated both the TNC Lot and Taxi Pool Lot in the fall of 2018. The project includes traffic signal modifications along Harborside Drive.
4. Terminal B Optimization	
Similar to the recent renovations and improvements at Terminal B, Pier A, Massport is upgrading its facilities on the Pier B side to meet airlines' needs (primarily reflecting the merger of American Airlines and US Airways) and to provide facilities that improve the passenger traveling experience. Planned improvements include an enlarged ticketing hall, improved outbound bag area, expanded baggage claim hall, expanded concession areas, and expanded holdroom capacity at the gates. The project will consolidate American Airlines operations to one pier of the terminal (currently operating on two different sides of the terminal); all Terminal B Pier B gates will be connected post security. The project will also consolidate checkpoint operations for better passenger throughput and improved passenger experience.	Massport prepared a Draft EA in May 2017 and a Final EA in June 2017. On June 29, 2017, the FAA issued a FONSI. Work on Pier B is substantially complete, with work on Pier A completed in the summer of 2019.
5. Terminal C to E Airside Connector	
A connector between Terminals C and E provides a greater post-security connectivity between terminals and improves flexibility for airlines. In addition, the Terminal C to E Connector provides a post-security connection between Terminals C and E on the Departures Level. The connector provides improved passenger circulation within the post-security concourse(s), additional holdroom space at Terminal E, reconfigured office space, concessions and concessions support, and a new consolidated location for escalators and stairs.	The Terminal C to E Airside Connector was a project component of the Renovations and Improvements at Terminals B & C/E Environmental Assessment approved by FAA in 2012. The Terminal C to E Airside Connector construction was completed in May 2016.

Table 3-3 Description and Status of Projects/Planning Concepts in the Terminal Area (December 31, 2018) (Continued)

Description	Status
Massport Projects/Planning Concepts	
6. Terminal C, Pier B Optimization This project will make improvements within the existing footprint of Terminal C, Pier B. Existing passenger areas will be renovated and a second level of less than 5,000 square feet will be added. A jet bridge will be installed at an existing aircraft parking position.	This project is in design and construction will begin in 2019.
7. Terminal C Canopy, Connector, and Roadway Project Massport is planning improvements that will enhance Terminal C facilities and provide a post-security connector between Terminals B and C, replace aging roadways serving the terminals, and improve the operation of the Terminal C curb. The enhancements also include replacement of the existing canopy on the Departures Level. The project will enhance Logan Airport's ability to efficiently accommodate current and future passenger volumes by bringing the terminal facilities up-to-date and improving access, egress, and drop-off/pick-up operations. Massport will also remove the "Old Tower" to accommodate the roadway and curb enhancements.	The FAA issued a FONSI in November 2018. Construction of the building enhancements is underway with roadway and canopy work expected to begin in fall of 2019.
8. Terminal A to B Landside Connector As part of the Airport-wide effort to enhance terminal connectivity, Massport completed a sheltered pedestrian connection between Terminals A and B.	The landside connection between Terminals A and B was completed in February 2016.
9. Terminal A to B Airside Connector As part of the Airport-wide effort to enhance terminal connectivity post-security, a secure-side connector between Terminals A and B is under consideration.	The airside connector between Terminals A and B is still being considered, however, this project is not currently in the five-year Capital Program.
10. Terminal A Improvements Massport is considering improvements to Terminal A including enhancements to passenger amenities and passenger processes. Interior improvements at both the main terminal and satellite terminal, reconfiguration and improvements at the security checkpoint, and new elevator construction will be included. The project considers the feasibility of post security connections between Terminals A and B, and Terminals A and E.	Massport issued a Request for Qualifications in April 2019 for design and construction services.

Source: Massport.
Notes: **See Figure 3-3** for the location of terminal area projects/planning concepts.
1 Massachusetts General Laws Chapter 30, Sections 61-62H. MEPA is implemented by regulations published at 301 Code of Massachusetts Regulations 11.00 (the "MEPA Regulations").

Airside Area Projects/Planning Concepts

The airside area includes all Logan Airport land from the edge of the terminal buildings to the Logan Airport harbor boundary, incorporating the Logan Airport apron, runways, gates, and other airfield operating facilities. Airside improvements include upgrades and improvements to the airfield to enhance the operational efficiency and safety of Logan Airport.

Among potential safety concerns at Logan Airport and airports nationwide are runway incursions, which occur when an aircraft, vehicle, or person enters the Airport's designated area for aircraft landings and take-offs. In 2019, in coordination with the FAA, Massport completed a comprehensive multi-year Runway Incursion Mitigation Study (RIM, or RIM Study) and Comprehensive Airfield Geometry Analysis to identify, prioritize, and develop strategies to help Massport mitigate incursion risk.[9] Massport identified and prioritized airfield locations where safety can be improved or that could be improved over the next 15 to 20 years, subject to federal, state, and local environmental reviews and permitting.

Massport is also currently exploring options to improve the layout and efficiency of the NSA by reorganizing the existing uses. **Table 3-4** describes the status of these and other projects (as shown on **Figure 3-4**) and planning concepts under consideration for Logan Airport's airside area as of December 31, 2018 and provides additional updates as available.

9 Information on FAA's RIM program can be found at https://www.faa.gov/airports/special_programs/rim/.

FIGURE 3-4 **Location of Projects/Planning Concepts on the Airside**

2017 Environmental Status and Planning Report

Notes: See Table 3-4 for a description of the numbered projects. Status as of December 31, 2018.

1. Runway 15L-33R RSA Improvement (complete)
2. Runway 4R Light Pier Replacement (complete)
3. Runways 22R and 33L RSA Improvements/ Runway 33L Light Pier Replacement (complete)
4. Runway 9-27 RSA Improvement
5. Runway Incursion Mitigation Study and Comprehensive Airfield Geometry Analysis

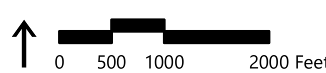


Table 3-4 Description and Status of Projects/Planning Concepts on the Airside (December 31, 2018)

Description	Status
1. Runway 15L-33R Runway Safety Area (RSA) Improvement Project As part of an ongoing program to improve safety at Logan Airport, and in close coordination with the Federal Aviation Administration (FAA), Massport proposed shifting existing Runway 15L-33R to accommodate an expanded RSA at the westernmost end (Runway 15L approach) of the runway. The project shifted the runway 200 feet to the southeast in order to comply with FAA standards requiring safety areas of 150 feet wide by 300 feet long at both ends of the runway.	The FAA issued a Categorical Exclusion on April 1, 2014. The project was completed in late 2014.
2. Runway 4R Light Pier Replacement Massport replaced the aging Runway 4R wooden approach light pier with a new modern structure with concrete pier/pilings.	Construction was completed in the fall of 2017.
3. Runways 22R and 33L RSA Improvements/Runway 33L Light Pier Replacement The Runway 33L timber light pier was constructed in 1960 and extended to the southeast 2,400 feet from the runway end, predominantly over Boston Harbor. A detailed alternatives analysis was conducted to evaluate options for safety enhancements at both runway ends. The Runway 33L RSA project initially proposed replacing the landward 500 feet of the light pier to bring the RSA up to current standards. During RSA construction, it was determined that the remaining 1,900 feet of the light pier should be replaced due to its advanced age and efficiencies of combining the construction with the RSA project in summer 2012 while the runway was already closed. As described in the Final Environmental Assessment/ Environmental Impact Report (EA/EIR), an Inclined Safety Area similar to what was constructed at Runway-End 22L was constructed for Runway End 22R. A pile-supported deck with an Engineered Materials Arresting System (EMAS) approximately 460 feet long by 300 feet wide was approved for Runway End 33L.	Massport filed an Environmental Notification Form (ENF) on June 30, 2009. A Draft EA/EIR was filed on July 15, 2010, and a Final EA/EIR on January 31, 2011, and the Secretary's Certificate was issued March 18, 2011. Remaining environmental permits were obtained by May 2011, and construction of the Runway 33L RSA was completed ahead of schedule in November 2012. Runway End 22R enhancements were completed in late 2014, including replacement of the EMAS installed in 2005. Massport filed a Notice of Project Change (NPC) to the Runway 33L Light Pier Replacement project in January 2012. The Secretary's Certificate was issued on March 9, 2012. All local, state, and federal permits were obtained for the additional work in June 2012, and the full replacement was completed in October 2012. As part of this project, the Runway 33L Instrument Landing System (ILS) approach, originally approved in the Airside Improvements Planning Project, was upgraded from Category I to Category III. Reduction in approach minimums on Runway 15R and Runway 33L was implemented in 2013, following the completion of the Runway 33L Light Pier replacement and FAA testing of new ILS equipment. Mitigation measures for eelgrass and salt marsh impacts have been implemented. See Chapter 9, *Environmentally Beneficial Measures and Project Mitigation Tracking*, for more information.

Table 3-4 Description and Status of Projects/Planning Concepts on the Airside (December 31, 2018) (Continued)

Description	Status
4. Runway 9-27 RSA Improvement Project	
As part of the Runway Incursion Mitigation (RIM) Study, RSAs at Logan Airport were analyzed for conformance with FAA standards. The FAA requires RSAs to accommodate aircraft overruns, undershoots, and veer-offs in emergency situations. Consistent with FAA requirements, Massport is continuously looking for opportunities to increase the margin of safety for all runways and, where practicable, providing the FAA standard for RSAs at all locations. At Logan Airport, the FAA standard for RSAs is typically 500 feet wide by 1,000 feet long at each runway end. Where this space is not available, FAA has approved the use of an EMAS for aircraft overrun protection. An EMAS uses a system of collapsible concrete blocks that can stop an aircraft by exerting predictable forces on the landing gear while minimizing aircraft damage. The RIM Study evaluated multiple alternatives for Runway 9-27 RSA enhancements and recommended construction of a deck, with an EMAS to meet the FAA safety requirements. The RSA at the end of Runway 27 is expected to be similar to the pile supported deck installed at Runway 33L.	The FAA issued a determination that approved the recommended alternative as it met applicable FAA safety requirements while minimizing environmental impacts. Massport expects to begin the environmental review and permitting process by the end of 2019.
5. Runway Incursion Mitigation (RIM) Study and Comprehensive Airfield Geometry Analysis	
FAA recently initiated a nationwide comprehensive multi-year RIM program to identify, prioritize, and develop strategies to help airport sponsors mitigate risk. Runway incursions occur when an aircraft, vehicle, or person enters the Airport's designated area for aircraft landings and take-offs.[1] Risk factors may include unclear taxiway markings, airport signage, and more complex issues such as runway or taxiway layout.	Massport has worked with FAA to identify areas that need to be addressed and plan for the implementation of safety measures. The study commenced in December 2016 and was completed in June 2019. Environmental review and permitting of the proposed improvements is expected to begin by the end of 2019.

Source: Massport.

Notes: See **Figure 3-4** for the location of airside projects/planning concepts.

1 Information on FAA's RIM program can be found at https://www.faa.gov/airports/special_programs/rim/.

Service Area Projects/Planning Concepts

Logan Airport's service areas contain airline support businesses and operations. Land uses in the service areas continue to evolve in response to changing airline business, customer and tenant needs, as well as public works projects. Massport continues to explore ways of efficiently using the limited land resources in the service areas. The six service areas at Logan Airport are shown in **Figure 3-5** and are described below.

- **North Cargo Area (NCA)** is in Logan Airport's northwest corner. It is bounded by the main Logan Airport outbound roadway to the south, Route 1A to the west, Prescott Street to the north, and Terminal E to the east. The NCA, which is adjacent to Logan Airport's airside area, is the Airport's primary airline support area. It accommodates essential airline support businesses including hangars, GSE maintenance, air cargo, and aircraft parking. The NCA will remain the most appropriate location for operations that require contiguous airside access. The future Terminal E Modernization Project will eventually occupy a portion of the NCA and will include terminal gates, aircraft parking, hangars, and cargo facilities. Portions of the NCA will continue to be used for economy parking. Expansion of the Economy Garage, as part of the Logan Airport Parking Project, is currently in the planning and permitting phase.
- **North Service Area (NSA)** is north of Prescott Street and extends to the Green Bus Depot Site, the MBTA Wood Island Station, and Runway End 15R. The NSA includes two flight kitchens, weather and navigation equipment, the Green Bus Depot, Facilities 2 and 3, the Large Vehicle Storage Facility, Hangar 5, BOSFuel Fuel Farm, Water Tanks, Signature Flight Support (a fixed-based operator), and Logan Airport Greenway, among others. The Greenway Connector and Narrow-Gauge Connector both run parallel to the MBTA Blue Line corridor in this section of the Airport. Massport is currently exploring options to improve the layout and efficiency of the NSA by reorganizing the existing uses which would expand Remain Over Night (RON) aircraft parking, remove an unused building in the RPZ, and improve overall land use.

  Also within the NSA, Massport is planning to expand its jet fuel storage facilities to be constructed opposite the Economy Garage. Massport proposes to enhance the reliability of jet fuel storage availability and distribution to meet current demand at Logan Airport by installing additional jet fuel storage facilities within the existing storage and distribution system. The proposed location for these additional facilities is the site of an abandoned Massport water pumping station, located on Prescott Street adjacent to the rear of the Economy Garage. Massport is currently evaluating siting configurations, conducting preliminary environmental screening, and identifying the project's state and federal environmental review and permitting requirements. The next phase of the project will include preliminary engineering, and environmental review and permitting.
- **Southwest Service Area (SWSA)** is south of Logan Airport's main access roadway and is bounded on the east by Harborside Drive. Because of its proximity to the terminals and the regional highway system, the SWSA functions as Logan Airport's primary ground transportation hub and includes the Rental Car Center (RCC), and the taxi, TNC, and bus/limousine pools. The RCC reduces Airport VMT and improves roadway and intersection operations through: consolidation of the rental car shuttle bus fleet and some Massport shuttle buses into a unified shuttle route system, resulting in the elimination of eight rental car bus fleets (a net total of 66 buses eliminated); improvement of intersection and roadway infrastructure, including signal coordination and dedicated ramp connections; and establishment of a Ground Transportation Operations Center (GTOC), enabling efficient planning and operation of Airport-wide transit activities. As part of the Terminal E Modernization Project, the existing on-Airport gas station will be relocated to the SWSA.

- **Bird Island Flats (BIF)** is located south of the Logan Airport SWSA. BIF has landside access via Harborside Drive and water access through the system of water taxis that shuttle passengers between downtown Boston, the South Shore, and Logan Airport. BIF development includes the Hyatt Hotel and Conference Center, the Logan Office Center and adjoining garage, an employee parking lot (Lot B), the Water Shuttle Dock, the Logan Airport Rescue and Fire Fighting Facility Marine Dock, and the Harborwalk, a publicly accessible promenade along the harbor's edge.
- **South Cargo Area (SCA)** is located southeast of the Logan Airport SWSA and is generally bounded on the south by Harborside Drive and on the east and north by Logan Airport's airside area. The SCA, which provides landside access and secured airside access, is Logan Airport's primary cargo area and accommodates domestic and international cargo operations.
- **Governors Island** is at Logan Airport's southern tip and is bounded by Runway 14-32 and Boston Harbor to the east and south, by Runway 4R to the west, and Runway 9 to the north. Governors Island has functioned as a storage site for the Central Artery/Tunnel (CA/T) Project and for construction stockpiles. The area also contains an Aircraft Rescue and Fire Fighting Facility training area, parking for snow removal equipment, a biocell remediation area, and FAA aircraft navigation equipment. The area has been considered as a future location of RON aircraft parking, and potentially other uses (including cold storage).

Table 3-5 presents information on the status of each ongoing project and planning concept in the service areas. Both Massport and Logan Airport tenants are proposing projects or exploring planning concepts to modernize and carry out future improvements to the service areas. The locations of the ongoing service area projects and planning concepts that may potentially be constructed in the future are shown on **Figure 3-6**.

FIGURE 3-5 Logan Airport Service Areas

2017 Environmental Status and Planning Report

Service Areas

0 500 1000 2000 Feet

FIGURE 3-6 **Location of Projects/Planning Concepts in the Service Areas**

2017 Environmental Status and Planning Report

Notes: See Table 3-5 for a description of the numbered projects. Status as of December 31, 2018.

1. SWSA Redevelopment Program (complete)
2. North Service Area (NSA) RPZ Enhancements
3. Jet Fuel Storage Addition - NSA
4. Group 1 Hangar - South Cargo Area
5. Governors Island Equipment Storage

Locations To Be Determined

6. Replacement Hangar
7. Relocated CNG Station - NCA
8. Replacement Cargo Facilities - NCA
9. New/Replacement SRE/GSE Building - NCA
10. Joint Operations Center

0 500 1000 2000 Feet

Table 3-5 Description and Status of Projects/Planning Concepts in the Service Areas (December 31, 2018)

Description	Status
Massport Projects/Planning Concepts	
1. Southwest Service Area (SWSA) Redevelopment Program The SWSA Redevelopment Program replaced and upgraded existing ground transportation uses within the SWSA. The redevelopment included a consolidated Rental Car Center (RCC) with a four-level garage to accommodate rental car retail operations and storage; support facilities for the car rental operations; a new clean-fuel unified shuttle bus system; a relocated and reconfigured taxi pool; bus and limousine pool; roadway improvements, pedestrian and bicycle facilities, and site landscaping. It also included a customer service center and four quick turn-around maintenance and service facilities. The RCC achieved Leadership in Energy and Environmental Design (LEED®) Gold certification in 2016. The Ground Transportation Operations Center (GTOC) within the RCC functions as the hub for management of ground transportation at the Airport. Phase II of the SWSA Airport Edge Buffer (EEA #14137) was integrated into the proposed SWSA Redevelopment Program (see **Table 3-5**).	A Final state Environmental Impact Report/federal Environmental Assessment (EIR/EA) was prepared in accordance with the Secretary of the Executive Office of Energy and Environmental Affairs (EEA)'s Certificate on the Notice of Project Change (NPC). The Final EIR/EA was filed on March 1, 2010. An extended public comment period closed on May 24, 2010. The Secretary's Certificate was issued on May 28, 2010, with finding that the Final EIR adequately and properly complied with the Massachusetts Environmental Policy Act (MEPA). The Federal Aviation Administration (FAA) issued a Finding of No Significant Impact (FONSI) on March 1, 2010. This project was completed in late 2014 and the RCC achieved LEED Gold certification in 2016. The SWSA Airport Edge Buffer was completed in late 2014.
2. North Service Area (NSA) Runway Protection Zone (RPZ) Enhancements Massport is evaluating safety enhancements in the RPZ at the approach end of Runway 15R. This area includes hangars, aircraft parking, the North Gate, aircraft fueling facilities, and other airfield maintenance support facilities.	Massport is working with FAA to study the feasibility of implementing RPZ enhancements. Elements of this project are expected to proceed before 2025.
3. Jet Fuel Storage Addition – NSA Massport proposes to enhance the reliability of jet fuel storage availability and distribution to meet current demand at Logan Airport by installing additional jet fuel storage facilities within the existing storage and distribution system. The proposed location for these additional facilities is the site of an abandoned Massport water pumping station, located on Prescott Street adjacent to the rear of the Economy Garage. The functions, facilities, and land use in the project area will remain generally consistent.	Massport is currently evaluating siting configurations, conducting preliminary environmental screening, and identifying the project's state and federal environmental review and permitting requirements. The next phase of the project will include preliminary engineering, and environmental review and permitting.
4. Group 1 Hangar – South Cargo Area This project would provide enclosed, climate-controlled space for light maintenance that currently is conducted on the open ramp area.	Design of the hangar is underway, and construction is expected to begin by late 2019. This project will undergo National Environmental Policy Act (NEPA) review.

Table 3-5 Description and Status of Projects/Planning Concepts in the Service Areas (December 31, 2018) (Continued)

Description	Status
Massport Projects/Planning Concepts	
5. Governors Island Equipment Storage Governors Island has been identified for a number of aviation support activities for many years. One current concept is for equipment storage. As an example, snow removal equipment could be stored there off-season. It would likely be a limited access type operation.	Massport is evaluating concepts for Governors Island.
6. Replacement Hangar (location to be determined) The former American Airlines Hangar has been demolished because it could no longer serve the American Airlines fleet. Plans are underway for a new hangar to accommodate Group V aircraft. The location of the replacement hangar is under consideration.	Demolition of the former American Airlines hangar commenced in 2014 and was completed in August 2016. Prior to demolition, American Airlines relocated to the refurbished former Northwest Hangar.
7. Relocated Compressed Natural Gas (CNG) Station in the North Cargo Area (NCA) (location to be determined) This would relocate Massport's existing CNG Station to accommodate the airside operations in the NCA.	Massport continues to examine potential on-Airport parcels for relocation of the existing CNG station. Relocation is not expected to occur before 2020.
Tenant Projects/Planning Concepts	
8. Replacement Cargo Facilities in the NCA (location to be determined) Construction of new cargo facilities in the NCA would compensate for the loss of cargo facilities due to the Central Artery/Tunnel (CA/T) Project, as well as for the projected growth in cargo demand.	The project remains under evaluation. If a decision were made to proceed with this project, construction would likely commence after 2025.
9. New/Replacement Snow Removal Equipment (SRE)/ Ground Support Equipment (GSE) Building in the NCA (location to be determined) This planning concept would provide multi-tenant maintenance facilities for GSE.	Construction would be complete by 2025.
10. Joint Operations Center (JOC) (location to be determined) The JOC is envisioned as a state-of-the-art operations and situational awareness center. The goal of the JOC is to capture the security and response benefits afforded through integrated incident dispatch and mobile response for public safety and security services. The program plans to bring the Operations Center, State Police Dispatch, Maritime Monitoring (with future Hanscom Field and Worcester Regional Airport monitoring), Transportation Security Administration (TSA) staff, and camera monitoring within the structure of one common facility.	Development of a common command and control JOC is in the feasibility phase.

Source: Massport.
Note: See **Figure 3-6** for the location of service area projects/planning concepts.

Airport Buffer Areas and Other Open Space

Previously, Massport committed over $15 million for the planning, construction, and maintenance of four Airport edge buffer areas and two parks along Logan Airport's perimeter (**Figure 3-7**). These buffers have been completed and include the Bayswater Embankment Airport Edge Buffer, Navy Fuel Pier Airport Edge Buffer, SWSA Airport Edge Buffer, and Neptune Road Airport Edge Buffer. These areas are located on Massport-owned property along Logan Airport's perimeter boundary and provide attractive landscape buffers between Airport operations and adjacent East Boston neighborhoods. The buffer design included consultation with Logan Airport's neighbors and other interested parties in an open community planning process. Today, East Boston enjoys 3.3 miles and more than 33 acres of green space developed or managed by Massport, in partnership with and in response to the East Boston community.

In September 2016, Massport officially opened the Bremen Street Dog Park. The park, the first of its kind in East Boston, provides 22,655 square feet of play space for neighborhood dogs. Other park amenities include exercise equipment for dogs, pet waste stations, and water fountains for both pets and their owners. Massport completed the construction of the Greenway Connector between Bremen Street Park and an overlook at Wood Island Marsh in March 2014. The one-half mile Greenway Connector connects the pedestrian/bicycle path to the City of Boston/Narrow-Gauge Connector to Constitution Beach. In 2016, construction on the Narrow-Gauge Connector was underway by the City of Boston. The Narrow-Gauge Connector is a one-third mile multi-use path and extension of the East Boston Greenway network which allows pedestrians and cyclists to travel between Piers Park and Constitution Beach. Massport assumed ownership and operation of the Narrow-Gauge Connector when it was completed in 2016. There are pedestrian and bike counters along the Greenway Connector and in 2017, there were 63,915 East Boston Greenway trips that were recorded by the counters compared to 43,787 in 2016.

As part of the Logan Impact Advisory Group (LIAG), Massport committed to developing Piers Park II, which will add approximately 4.2 acres of green space to the East Boston waterfront upon completion. The conceptual design of the Phase II site envisions a fully accessible park with a central lawn area, basketball and volleyball courts, and bicycle and rollerblade tracks. A Request for Proposals for design of Piers Park Phase II was issued by Massport in June 2017. The planning and design process is underway; it is expected to take 18 months and to be completed in 2020.

Piers Park Phase III is conceived as a 3.8-acre addition of green space to the existing Piers Park on the East Boston waterfront. The Phase III site is located adjacent to the Phase II site, along Marginal Street in East Boston. Piers Park Phase III is an early-stage planning concept that Massport has made available to external developers. Piers Park Phase III would turn an aging pier into a 3.6-acre greenspace that includes resiliency features to help protect the neighborhood from flooding and sea level rise. Massport issued a Request for Proposals in February 2018 for design and construction of Piers Park Phase III. There was only one respondent, and advancement of this concept is dependent on that respondent's financial and design prospects. Site feasibility studies are underway.

Figure 3-7 Parks Owned and Operated by Massport and City of Boston

Source: Massport, VHB.

To collaborate in East Boston open space planning, Massport also participates in meetings with other agencies including the Massachusetts Department of Transportation (MassDOT), the City of Boston, and the MBTA. **Table 3-6** describes the status of ongoing buffer projects and other Massport green space projects under consideration as of December 2017. **Figure 3-8** shows the location of these buffer projects.

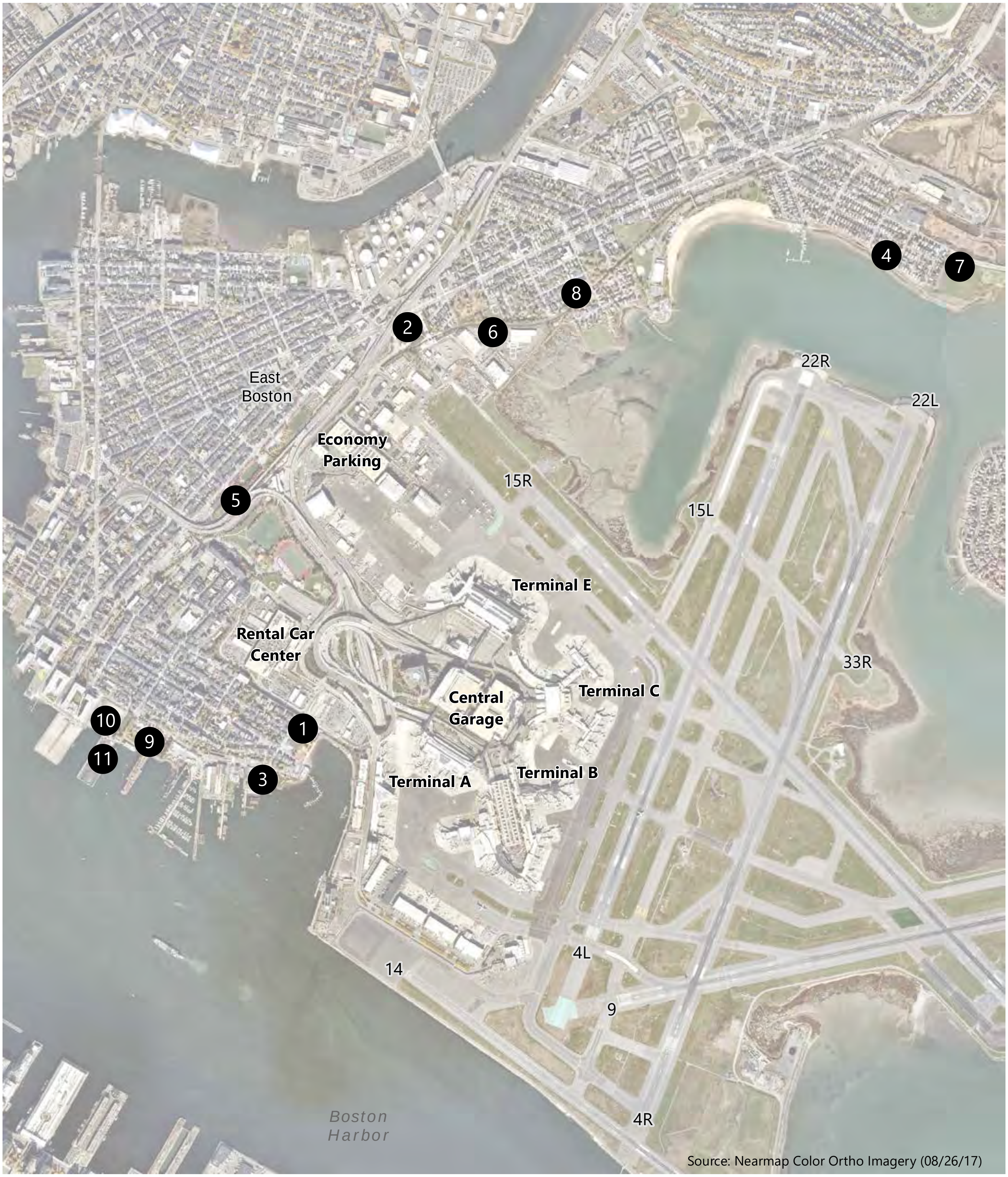


FIGURE 3-8 Location of Airport Buffer Projects/Open Space

2017 Environmental Status and Planning Report

Notes: See Table 3-6 for a description of the numbered projects. Status as of December 31, 2018.

1. SWSA Airport Edge Buffer (Phases I and II) (complete)
2. Neptune Road Airport Edge Buffer (complete)
3. Navy Fuel Pier Airport Edge Buffer (complete)
4. Bayswater Embankment Airport Edge Buffer (complete)
5. Bremen Street Park and Dog Park (complete)
6. Greenway Connector (complete)
7. Community Greenway Enhancements (complete)
8. Narrow-Gauge Connector (complete)
9. Piers Park Phase I (complete)
10. Piers Park Phase II
11. Piers Park Phase III (by others)

0 500 1000 2000 Feet

Table 3-6 Description and Status of Airport Edge Buffer Projects/Open Space (December 31, 2018)

Description	Status
1. Southwest Service Area (SWSA) Airport Edge Buffer (Phases I and II)	
Phase I of this project involved the construction of an approximately half-acre area with landscaping and lighting improvements along Maverick Street that included evergreen and deciduous trees, ornamental shrubs, and groundcovers. Phase II consisted of installing landscaping (i.e., densely planted or planted atop earth berms for enhanced separation) and solid barriers such as fences and walls. The project enhanced bicycle and pedestrian connectivity between Maverick Street and East Boston Memorial Park and Stadium with extensive landscaping including trees, shrubs, flowering perennials, and decorative fences.	Phase I construction was completed in 2006. Phase II of the SWSA Airport Edge Buffer design was integrated with the SWSA Redevelopment Program. Construction of the SWSA Phase II Airport Edge Buffer was completed in Fall 2014.
2. Neptune Road Airport Edge Buffer	
The Neptune Road Airport Edge Buffer is a Massport community mitigation project intended to buffer the East Boston Neighborhood at Logan Airport's northwestern edge. The 1.5-acre Neptune Road Airport Edge Buffer is at the nexus of Neptune Road, Vienna, and Frankfort Streets and is adjacent to the Massachusetts Bay Transportation Authority's (MBTA's) Wood Island Station. The majority of the parcel is located within the Runway Protection Zone (RPZ) for Runway 15R-33L. The project consists of Olmsted-inspired landscape with various interpretive elements that will complement the adjacent North Service Area Roadway Corridor and be a continuation of the Corridor's pedestrian/bicycle path to Bennington Streets. The landscape elements reference Frederick Law Olmsted's original choice of materials and designs for Wood Island Park while preserving some of the existing trees. A pedestrian/bikeway link along Vienna Street to Bennington Street from the North Service Area Roadway Corridor was included, as well as a historical timeline, cast-iron neighborhood sculptures, foundation ghosting of the last two demolished residential structures, and cast-iron house number plaques in the sidewalk along Neptune Road. Additional buffer elements include low stone walls, concrete sidewalks, bicycle racks, solar trash compactors, fencing, and period light fixtures.	The Neptune Road Airport Edge Buffer was completed in June 2016.
3. Navy Fuel Pier Airport Edge Buffer	
The Navy Fuel Pier Airport Edge Buffer project began with the U.S. Army Corps of Engineers' remediation of the former Navy Fuel Pier, which was completed in 2001. The project involved beautification of this 0.7-acre property through landscape improvements and stabilization of the waterfront perimeter. An interpretive panel was also installed which details the history of the surrounding area.	Construction of the Navy Fuel Pier Airport Edge Buffer was completed in 2007.

Table 3-6 Description and Status of Airport Edge Buffer Projects/Open Space (December 31, 2018) (Continued)

Description	Status
4. Bayswater Embankment Airport Edge Buffer	
This project involved creating a landscaped buffer between Bayswater Street and Boston Harbor.	Construction of this Airport edge buffer was completed in 2003. Massport is currently evaluating options for repairing recent storm-related shoreline damage.
5. Bremen Street Park and Dog Park	
The 18-acre park was constructed as part of the Central Artery/Tunnel (CA/T) Project. The park, which is the second largest neighborhood park in East Boston, offers a variety of facilities, a direct pedestrian connection to the Massachusetts Bay Transportation Authority (MBTA) Blue Line Airport Station, and a half-mile segment of the three-mile East Boston Greenway. The park was built on land previously used as off-Airport parking. This 22,655 square-foot park is located on the corner of Bremen and Porter Streets in East Boston.	Construction of the park was completed in 2008. Massport continues to operate the park and provide community facilities. The Dog Park was opened in September 2016.
6. Greenway Connector	
The one-half mile pedestrian/bicycle path connects the Bremen Street Park pedestrian/bicycle path to the Narrow-Gauge Connector. Together the Greenway and Narrow-Gauge Connectors provide a continuous path connecting Piers Park, Bremen Street Park, Stadium Park, and Constitution Beach.	Construction of the Greenway Connector between Bremen Street Park and an Overlook at Wood Island Marsh was completed by Massport in 2014.
7. Community Greenway Enhancements	
Eight street lights were installed along Saratoga Street to improve safety and maintain spacing consistent with what was existing.	The lighting improvements were substantially completed by December 2015.
8. Narrow-Gauge Connector	
The Narrow-Gauge Connector is a one-third mile multi-use path and extension of the East Boston Greenway network. Now completed, this portion of the East Boston Greenway allows people to continuously walk from Piers Park to Constitution Beach.	Construction of this project was ongoing in 2016 and the Narrow-Gauge Connector was opened in May 2016. The City of Boston completed final plantings in Spring of 2016, and turned the project over to Massport for ownership, maintenance, and security.
9. Piers Park Phase I	
Formerly a 7-acre industrial site located on the East Boston waterfront, the Phase I site is comprised of three distinct zones: 5.5-acre backland, 1.2-acre pier, and a community sailing facility. The park includes a picnic area, adult fitness course, children's playground and spray park, and an outdoor amphitheater.	Construction was completed in 1995.

Table 3-6 Description and Status of Airport Edge Buffer Projects/Open Space (December 31, 2018) (Continued)

Description	Status
10. Piers Park Phase II	
Piers Park Phase II will add 4.2 acres of green space to the existing Piers Park on the East Boston waterfront. The Phase II site is located adjacent to the Phase I site, along Marginal Street in East Boston. The conceptual design of the Phase II site envisions a fully accessible park with a central lawn area, basketball and volleyball courts, and bicycle and rollerblade tracks. Massport has committed up to $15 million for the design and construction of this new waterfront park. This new park is expected to offer resiliency landscape features similar to those in the Phase I Park, including brick paved walkways, site furniture, lighting, and plantings. A new 1,000-square foot community/sailing center, located on the waterfront, is designed to replace the existing Sailing Center building while providing additional meeting spaces for the community.	Massport issued a Request for Proposals for design of Piers Park Phase II in June 2017. The planning and design process is expected to take approximately 18 months and is expected to be completed by August 2020.
11. Piers Park Phase III (*by others*)	
Piers Park Phase III is conceived as a 3.8-acre addition of greenspace to the existing Piers Park on the East Boston waterfront. The site is located adjacent to the Phase II site, along Marginal Street in East Boston. Piers Park Phase III would turn an aging pier into a 3.6-acre greenspace that includes resiliency features to help protect the neighborhood from flooding and sea level rise.	Massport issued a Request for Proposals in February 2018 for design and construction of Piers Park Phase III. There was only one respondent, and advancement of this concept is dependent on that respondent's financial and design prospects. Site feasibility studies are underway.

Source: Massport.
Note: See **Figure 3-8** for the location of Airport edge buffer projects/planning concepts.

Energy, Resiliency, and Sustainability Planning

As part of an authority-wide initiative, Massport recently completed or is undertaking several airport-wide energy, resiliency, and sustainability planning efforts described below.

Energy Planning

Massport is committed to energy conservation and has been investing in energy efficiency measures such as high efficiency lighting and automated building energy management systems. Third-party energy efficiency and solar development initiatives are under review. An individual third-party solar project has been advertised and is currently pending award. Supply-side energy procurement continues under the Massport Energy Hedge Strategy.

Massport is studying opportunities to maximize solar installations across Logan Airport and is installing electric vehicle infrastructure on the airside and in the parking garages. Massport has numerous solar panel installations at Logan Airport including locations on top of the Economy Garage, Rental Car, Center, Terminal A, and Terminal B Garage. The Terminal E Modernization Project includes a planned 300,000-kilowatt hour (kWh) rooftop solar array, while the Terminal C Canopy, Connector, and Roadway Project includes a 250,000-kWh rooftop solar array. In addition, Massport is reviewing options for the installation of solar panels at the planned new Terminal E parking garage.

In 2018, the EPA awarded a $541,817 grant to Massport to replace diesel powered GSE at Logan Airport. This grant will be used in conjunction with an FAA VALE grant Massport received in the fall of 2018 to install eGSE charging stations as part of the Terminal B Optimization Project. On the landside, Massport has installed electric charging facilities in all its garages and will also install them in the proposed new garage in front of Terminal E and the expanded Economy Garage.

Resiliency Planning

Massport has a robust effort underway that first identified vulnerabilities on the Airport and is now incorporating resilient infrastructure design standards for all types of Airport projects. At the end of 2013, Massport initiated a Disaster and Infrastructure Resiliency Planning Study (DIRP) for Logan Airport, the Port of Boston, and Massport's waterfront assets in South and East Boston. The DIRP Study includes a hazard analysis, models of sea-level rise and storm surge, and projections of temperature and precipitation and anticipated increases in extreme weather events. The DIRP Study provides recommendations regarding short-term strategies to make Massport's facilities more resilient to the likely effects of climate change. The study was completed and implementation of adaptation initiatives began in late 2014.

In addition to the DIRP Study and its related initiatives, Massport has completed an Authority-wide risk assessment, as part of its strategic planning initiative; issued a Floodproofing Design Guide; and has developed a resilience framework to provide consistent metrics for short- and long-term planning and protection of its critical facilities and infrastructure. Beyond infrastructure resiliency, Massport is also focused on incorporating social and economic resilience into its long-term operational and capital planning. Massport's Floodproofing Design Guide was published in November 2014 and updated in April 2016.

Operational aspects of resiliency strategy include the development of Flood Operations Plans for Logan Airport and Massport maritime facilities. These plans were introduced in 2015 and included the planned deployment of temporary flood barriers to protect up to 12 locations of critical infrastructure in the event of severe weather. The test deployments and live event staging for the March 2018 Nor-easters succeeded in managing and tracking flood barrier deployment logistics and effective communication. As a result, Logan Airport's Flood Operations Plans and operational responses have evolved. A web-based coastal flood resiliency application was developed to better manage planning immediately prior to an event impact, and to facilitate operational recovery as quickly as possible.

Additional locations have been permanently enhanced to prevent flooding. The flood operations plans are evaluated annually to enhance their effectiveness and to adapt to evolving requirements and past experiences. As reported in the Sustainable Massport 2018 Annual Sustainability and Resiliency Report, over 60 percent of critical assets such as electrical power facilities, diesel fuel pumping stations, telecommunications systems, and police and fire public safety buildings have been enhanced with resiliency measures. Floodproofing measures include: installing temporary flood barriers for facilities, raising electrical and mechanical equipment above forecasted flood levels, sealing and waterproofing openings and conduits; installing water sensors and pumps, and installing anchoring systems for the deployment of temporary flood fencing and flood barriers in the event of an emergency.

In 2017, Massport conducted a series of workshops with key stakeholders to review and continuously improve its Flood Operations Plans. In addition, many education and training opportunities have been provided to staff and emergency responders to increase operational preparedness for flood events. In March 2018, Massport conducted several test deployments of flood barriers at three critical Logan Airport assets. Additionally, Massport developed a flood resiliency application to inform decision-making, facilitate management oversight, and enable real-time field updates via mobile devices before, during, and after storm events.

Logan Airport Sustainability Planning

In 2013, Massport was awarded a grant by FAA to prepare an SMP for Logan Airport. The Logan Airport SMP planning effort began in May 2013 and was completed in April 2015. The purpose of the Logan Airport SMP is to enhance the efficiency and sustainability of Logan Airport's operations and to support the broader sustainability principles of the Commonwealth. The Logan Airport SMP takes a comprehensive approach to sustainability including economic vitality, social responsibility, operational efficiency, and natural resource conservation considerations. The Logan Airport SMP is intended to promote, integrate, and coordinate sustainability efforts across the Authority. The Logan Airport SMP was developed with a framework and implementation plan, with metrics and targets designed to track progress over time. Massport is currently advancing a series of short-term initiatives to help reach its goals in the areas of energy and greenhouse gas emissions; community, employee, and passenger well-being; resiliency; materials, waste management, and recycling; and water conservation.

Massport Annual Sustainability and Resiliency Report

The Massport Annual Sustainability and Resiliency Report provides a progress summary of sustainability efforts at Logan Airport and other Massport facilities, based on Massport's sustainability goals and targets established in the Logan Airport SMP. The first report, titled the Logan Airport Annual Sustainability Report, was published in April 2016 and focused on Logan Airport only. Since the publication of the 2016 report, Massport has continued expanding its sustainability initiatives, with an increased focus on implementing resiliency measures to protect Maritime and Logan Airport operations, critical infrastructure, and workforce. The lastest Annual Sustainability and Resiliency Report highlights Massport's progress towards improving sustainability and enhancing resiliency at its facilities and is available on Massport's website at: http://www.massport.com/massport/business/capital-improvements/sustainabiity/sustainability-management/.

Annual Sustainable Massport Calendar

Each year since 2015, Massport distributes *Sustainable Massport* calendars to employees and other stakeholders. The calendars are filled with examples of Massport's sustainability projects and successes, and each month highlights aspects of environmental, social, and economic aspects of sustainability to which employees can contribute.

Source: Massport.

Massport Sustainability 2.0

Massport is continuing to incorporate sustainability considerations into its projects and is currently working on a vision for Massport "Sustainability 2.0." The vision for this next-level planning effort is to implement principles and approaches from the Logan Airport SMP at other Massport facilities and to update Massport's sustainability goals and targets. In early 2019, Massport conducted a series of charrettes with Massport staff, tenants, and business partners to help define this vision. Massport is currently working on a detailed set of recommendations for Sustainability 2.0. Updates will be reported in future Annual Sustainability and Resiliency Reports.

This Page Intentionally Left Blank.

4

Regional Transportation

Key Findings

- In 2017, the New England region saw an increase in air passenger activity. Regional air passengers increased by 5.5 percent to 54.7 million air passengers in 2017, a historic high. The 10 regional airports (excluding Boston Logan International Airport [Logan Airport or the Airport]) in New England accommodated 16.3 million air passengers in 2017, compared to 15.6 million passengers in 2016.
- Worcester Regional Airport, Bradley International Airport, T.F. Green Airport, Portland International Jetport, and Burlington International Airport saw an overall increase in service offerings in 2017. Manchester-Boston Regional and Tweed-New Haven airports saw reduced service offerings in 2017.
- The Massachusetts Port Authority's (Massport's) three airports, Logan Airport, Worcester Regional Airport, and Hanscom Field, make significant contributions to the regional economy, generating approximately $23.1 billion annually, or 94 percent of the overall economic benefits generated by the Massachusetts airport system.
- Worcester Regional Airport saw passenger numbers increase 32 percent in 2018 compared to 2017 and reported a total of approximately 600,000 passengers from 2013 to 2018. In the past five years, Worcester Regional Airport has experienced an average growth rate of 30 percent per year.
- Massport continues to invest in Worcester Regional Airport—together with the City of Worcester, Massport has already initiated a $100 million, 10-year investment to revitalize and attract commercial operations to Worcester Regional Airport.
    - Recently, Massport installed a Category (CAT) III Instrument Landing System (about $32 million) paid for by federal grants and Massport funds.
    - jetBlue Airways, American Airlines, and Delta Air Lines announced new service to New York John F. Kennedy International Airport (JFK), Philadelphia International Airport, and Detroit Metropolitan Wayne County Airport, respectively.
- Hanscom Field is a reliever airport to Logan Airport and is the second busiest airport in New England.
- Amtrak rail system-wide ridership remained flat at 31.7 million customer trips from fiscal year (FY) 2017 to FY 2018. The Northeast Corridor (NEC) carried over 12 million passengers, up about 1 percent from the prior year. In mid-2018, Amtrak announced $370 million in investments in new equipment to install double track infrastructure maintenance capacity on the NEC over the next three years, along with next-generation Acela Express trainsets that will increase per train seat capacity by 27 percent.[1]

1 Amtrak. 2018. *FY 18 Company Profile*. http://media.amtrak.com/wp-content/uploads/2019/03/Amtrak-Corporate-Profile_FY2018_Pub-March-1-2019.pdf.

Introduction

This chapter places Logan Airport in the context of the New England region's intermodal transportation system and reports on the status of the region's airports and other intermodal facilities in 2017. Logan Airport, one of three airports owned and operated by Massport, is the primary international and domestic airport operating within a larger network of New England regional airports.[2] Massport also owns and operates Worcester Regional Airport and Hanscom Field; both of these airports play important roles in the New England regional transportation system, as described below. This chapter focuses on 2017 and specifically describes passenger and aircraft operations activity levels at New England regional airports,[3] including consideration of:

- Changes in airline service levels and other factors that have contributed to trends in regional airport activity;
- The status of current improvement plans and projects at the regional airports;
- Massport's initiatives and joint efforts with other transportation agencies to improve the efficiency of the New England regional transportation system; and
- Regional long-range transportation planning efforts.

New England Regional Airports

As shown in **Figure 4-1**, the New England region is anchored by Logan Airport and a system of 10 other commercial service, reliever, and general aviation (GA) airports (regional airports).[4] Together, these 11 airports accommodated 54.7 million passengers in 2017, approximately 98 percent[5] of New England's air travel demand. These airports include:

- Logan Airport (BOS)
- Worcester Regional Airport (ORH)
- Hanscom Field (BED)
- Bradley International Airport (BDL)
- T.F. Green Airport (PVD)
- Manchester-Boston Regional Airport (MHT)
- Portland International Jetport (PWM)
- Burlington International Airport (BTV)
- Bangor International Airport (BGR)
- Tweed-New Haven Airport (HVN)
- Portsmouth International Airport (PSM)

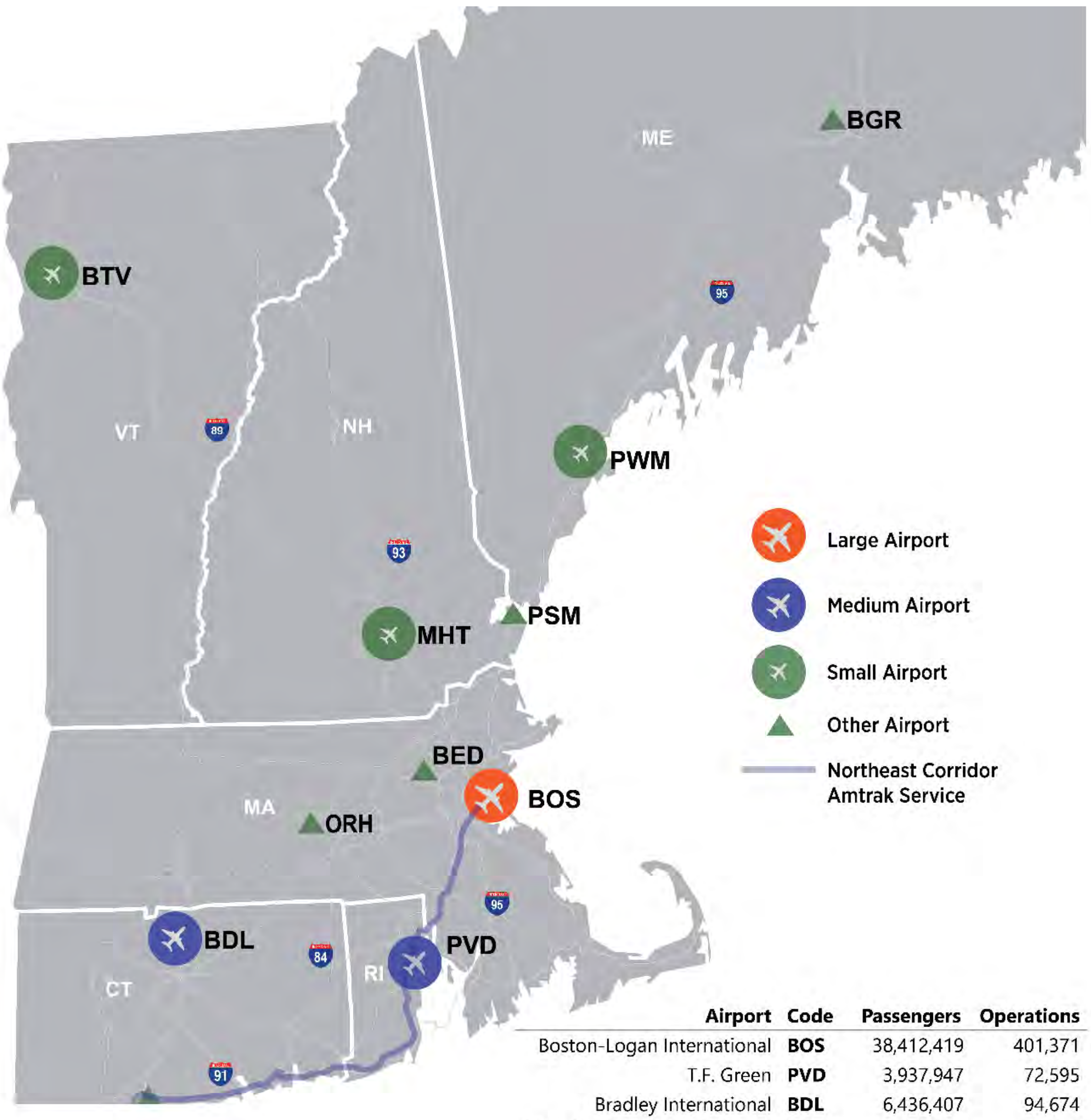
2 A regional airport is an airport serving traffic that supports regional economies by connecting communities to statewide and interstate markets.

3 A review of passenger and operations activity levels at Logan Airport is provided in Chapter 2, *Activity Levels*.

4 The *New England Regional Airport System Plan* (NERASP), which was published by the Federal Aviation Administration in 2006, includes Logan International Airport and these 10 regional airports: Bangor International, Bradley International, Burlington International, Hanscom Field, Manchester-Boston Regional, Portland International, Portsmouth International, T.F. Green, Tweed-New Haven, and Worcester Regional airports.

5 Federal Aviation Administration. 2017. Final Calendar Year (CY) 2017 Passenger Boarding Data.

Figure 4-1 New England Regional Transportation System – 2017 Passenger and Operations Activity Levels at the 11 Commercial Service Airports



Airport	Code	Passengers	Operations
Boston-Logan International	**BOS**	38,412,419	401,371
T.F. Green	**PVD**	3,937,947	72,595
Bradley International	**BDL**	6,436,407	94,674
Manchester-Boston Regional	**MHT**	1,970,688	51,716
Burlington International	**BTV**	1,181,520	66,150
Portland International Jetport	**PWM**	1,862,213	51,805
Portsmouth International	**PSM**	190,914	49,302
Hanscom Field	**BED**	14,264	128,598
Worcester Regional	**ORH**	110,006	30,107
Tweed New Haven Regional	**HVN**	57,514	25,783
Bangor International	**BGR**	531,348	43,016

Source: Federal Aviation Administration (FAA). 2018. *Airport Categories*. https://www.faa.gov/airports/planning_capacity/passenger_allcargo_stats/categories/

Note: Airport sizes are based on the FAA definition: Large Hub (1 percent or more of U.S. annual passenger boardings), Medium Hub (at least 0.25 percent, but less than 1 percent), Small Hub (at least 0.05 percent, but less than 0.25 percent); Other (Nonhub Primary – more than 10,000, but less than 0.05 percent).

Logan Airport serves a major domestic origin and destination (O&D)[6] market and is the primary international gateway for the region. The regional airports range in role and activity levels, from Bradley International Airport, which served over 6.4 million commercial passengers in 2017, to Hanscom Field, which does not currently handle any scheduled commercial flights but serves as New England's largest GA facility.

In addition to Logan Airport and the 10 regional airports shown in **Figure 4-1**, a third tier of commercial airports serves relatively isolated communities or provides seasonal or niche commercial air services in New England. These airports include:

- Hyannis Airport, Martha's Vineyard Airport, Nantucket Memorial Airport, New Bedford Regional Airport, and Provincetown Municipal Airport in Massachusetts;
- Augusta State Airport, Bar Harbor Airport, Rockland Airport, and Northern Maine Regional Airport in Maine;
- Lebanon Municipal Airport in New Hampshire;
- Block Island State Airport and Westerly State Airport in Rhode Island; and
- Rutland Southern Vermont Regional Airport in Vermont.

These third-tier airports support frequent commercial service to Logan Airport and, in some instances, T.F. Green Airport during the summer months. Most of these third-tier airports are not in close proximity to Logan Airport and are isolated due to geographic factors. Because of their remoteness and/or limited market areas, many of these airports are unlikely to attract passengers that now fly from Logan Airport. Instead, many of these airports are dependent on Logan Airport for connecting services.

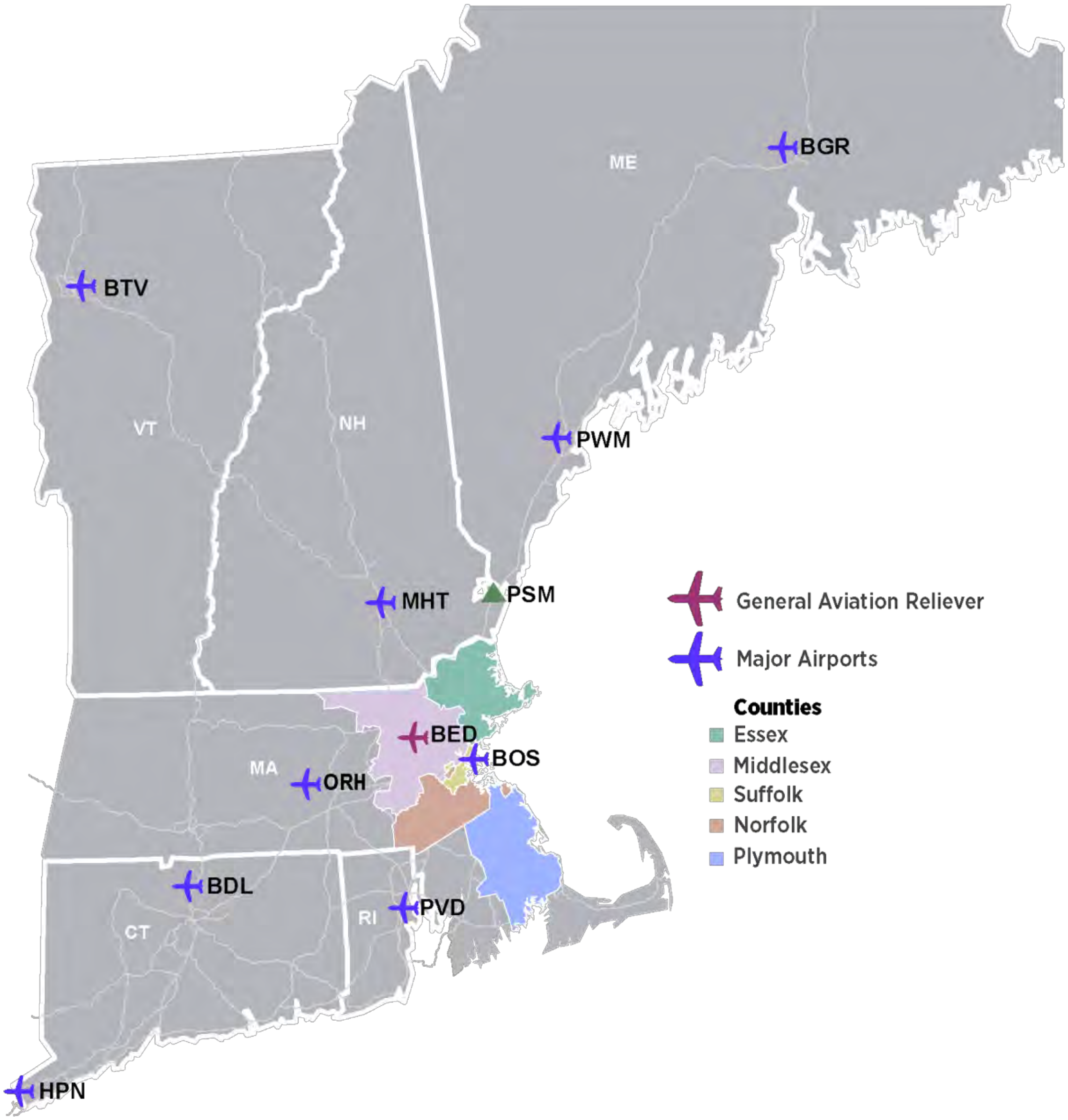
Strong Regional Economy Drives Growth at Logan Airport

The area surrounding Logan Airport has demonstrated strong economic growth over the last 10 years, reflecting the interdependent relationship between the regional economy and Logan Airport. The 2019 Massachusetts Department of Transportation (MassDOT) Statewide Airport Economic Impact Study reported a 22-percent increase in total dollar economic output at Logan Airport from 2014 to 2019, which reflects increased contributions from visitor spending, airline and general aviation passenger traffic, new on-airport businesses, and returns on strategic investments. The robust regional economy drives passenger and cargo demand, both inbound and outbound, for the Airport. Similarly, the Airport's air service enables businesses to serve customers outside of New England as well as tourists who use services provided by local businesses.

Logan Airport is the largest airport in the six-state New England region, which has a population of approximately 14.8 million residents (see **Figure 4-2**). The Airport is located in Massachusetts, which is home to approximately 6.8 million residents, or 46 percent of the total population of New England. The Airport serves passengers from across New England, with its primary catchment area consisting of five Massachusetts counties: Essex, Middlesex, Norfolk, Plymouth, and Suffolk (which includes the City of Boston). According to the most recently available statistics, 4.4 million people reside in this five-county area (see **Table 4-1**).

6 "Origin and destination" (O&D) traffic refers to the passenger traffic that either originates or ends at a particular airport or market. A strong O&D market like Boston generates significant local passenger demand, with many passengers starting their journey and ending their journey in that market. O&D traffic is distinct from connecting traffic, which refers to the passenger traffic that does not originate or end at the airport but merely connects through the airport en route to another destination.

Figure 4-2 Boston Logan International Airport Catchment Area



Source: VHB.

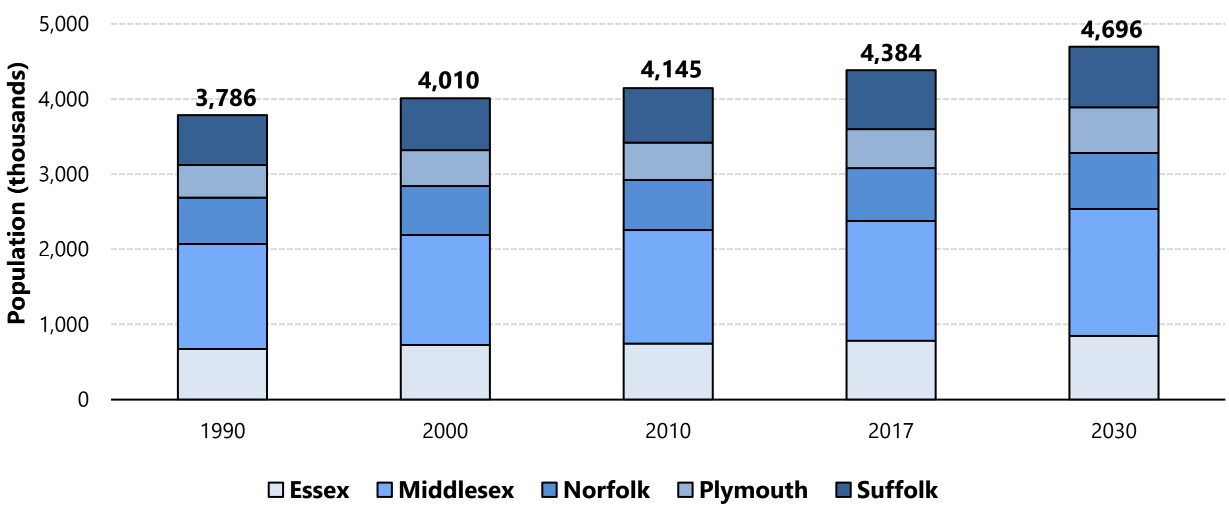
Notes: BDL – Bradley International Airport; BED – Lawrence G. Hanscom Field; BGR – Bangor International Airport; BOS – Boston Logan International Airport; BTV - Burlington International Airport; HPN – Westchester County Airport; MHT – Manchester-Boston Regional Airport; PVD – T. F. Green Airport; PWM – Portland International Jetport.

Table 4-1 Population of Logan Airport Primary Catchment Area, 1990, 2000, 2010, 2017

	Population (thousands)				Compound Annual Growth Rates		
County	**1990**	**2000**	**2010**	**2017**	**1990-2000**	**2000-2010**	**2010-2017**
Essex	671	725	746	783	0.8%	0.3%	0.7%
Middlesex	1,399	1,467	1,507	1,596	0.5%	0.3%	0.8%
Norfolk	617	651	672	700	0.5%	0.3%	0.6%
Plymouth	436	474	495	519	0.8%	0.4%	0.7%
Suffolk	663	693	725	786	0.4%	0.5%	1.2%
Boston Catchment Area	**3,786**	**4,010**	**4,145**	**4,384**	**0.6%**	**0.3%**	**0.8%**
Massachusetts	6,023	6,361	6,565	6,844	0.6%	0.3%	0.6%
New England	13,230	13,950	14,468	14,808	0.5%	0.4%	0.3%
U.S.	249,623	282,162	309,347	325,888	1.2%	0.9%	0.8%

Source: Woods & Poole Economics, Inc. 2018. Complete Economic and Demographic Data Source (CEDDS).

Figure 4-3 Logan Airport Primary Catchment Area Population Growth, 1990, 2000, 2010, 2017, 2030



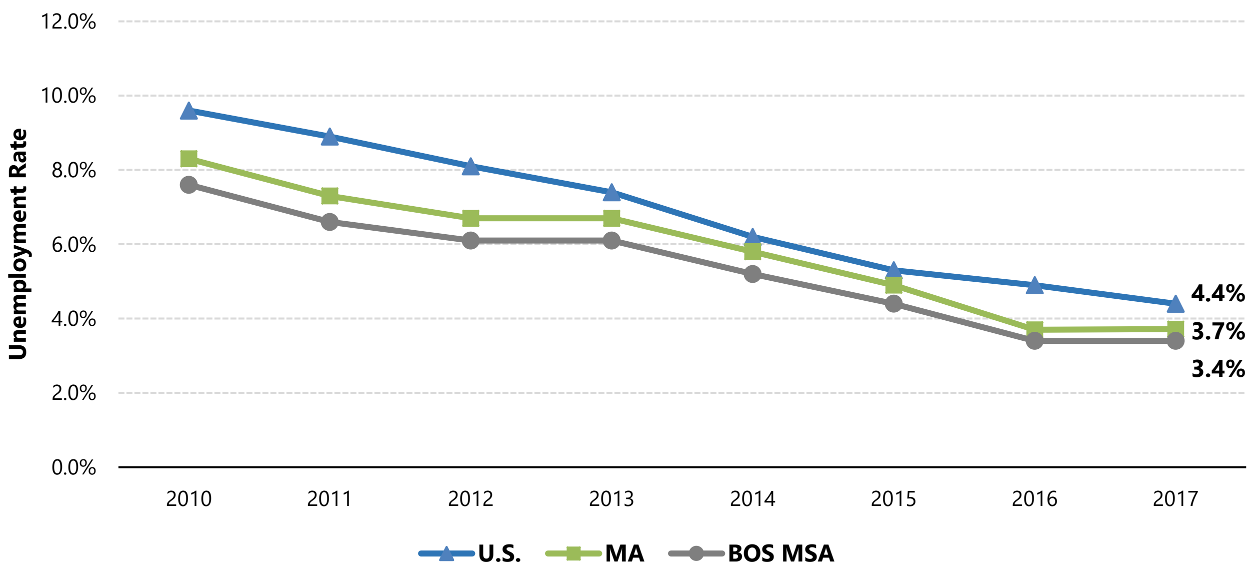
Source: Woods & Poole Economics, Inc. 2018. Complete Economic and Demographic Data Source (CEDDS).

Logan Airport is expected to continue its dominance due to the relatively rapid growth of the population of the catchment area (0.8 percent) compared to that of the U.S. (0.8 percent), Massachusetts (0.6 percent), and New England (0.3 percent) since 2010 (see **Table 4-1**). The catchment area population is projected to increase at an average rate of 0.5 percent each year over the next 13 years (see **Figure 4-3**).

Another reflection of the strength of the Airport's regional market is its relatively low unemployment rate. The Boston metropolitan area has consistently maintained a lower unemployment rate than that of the Commonwealth and the entire country (see **Figure 4-4**). In 2017, the Boston metropolitan statistical area had an unemployment rate of 3.4 percent, which is lower than the rate in the Commonwealth (3.7 percent) and the country (4.4 percent). Even during the 2008/2009 economic downturn, Boston and the Commonwealth experienced unemployment rates below the national average.[7]

The Airport not only serves a growing population, but a high earning one as well. Per capita income in 2017 was $65,941 (2009 U.S. dollars) in the Airport's primary service area, 11.2 percent higher than the Commonwealth and 45.5 percent higher than the national average.[8]

Figure 4-4 Unemployment Rate Comparison: U.S., Massachusetts, and Boston Metropolitan Statistical Area (MSA), 2010–2017



Source: U.S. Bureau of Labor Statistics. 2017.

Logan Airport is a key transportation and economic resource in the New England region, the state, and the Boston metropolitan area, which is home to a broad range of industries. The industries accounting for the largest share of employees include: healthcare and social assistance; educational services; and professional, scientific, and technology services (which include Boston's growing biotech industry).[9] In 2017, Boston was

7 U.S. Bureau of Labor Statistics. 2017.

8 Woods & Poole Economics, Inc. 2018. ICF Analysis of Population and Personal Income Datasets.

9 U.S. Census Bureau via DataUSA. 2017. Boston-Cambridge, Newton, MA-NH Metro Area Profile. www.datausa.io.

declared the "#1 city in the U.S. for fostering entrepreneurial growth and innovation."[10] The contribution of innovation and business start-ups is also evident in the latest 2017 year-to-date economic growth estimates and reflects trends in increased employment and high-tech industries. Furthermore, the Massachusetts economy saw 2.7 percent growth in 2018,[11] comparable to U.S. growth of 2.9 percent.[12]

Massachusetts Aviation Economic Impact Study

In addition to supporting the growth and economic success of the state, Logan Airport and the airport industry are important elements in the state and regional economy. The *Massachusetts Statewide Airport Economic Impact Study Update*, completed by the Aeronautics Division of MassDOT in 2014 and most recently updated in 2019,[13] assesses the contribution of the statewide airport system (the 39 public use airports, including Logan Airport) to the economy of Massachusetts. The analysis found that Massachusetts public use airports generated $24.7 billion in total economic activity (this includes on-Airport businesses, construction, visitor, and multiplier effects). **Figure 4-5** shows the total impact of Massachusetts airports in terms of employment, payroll, and total output.[14] In particular, the analysis noted that Massport's three airports make significant contributions to the regional economy, generating approximately $23.1 billion, or 94 percent of the overall economic benefits generated by the Massachusetts airport system. Specifically, Logan Airport supports over 162,000 direct and indirect jobs, while generating approximately $16.3 billion per year in total economic activity.[15] For every $100 spent by aviation-related businesses, an additional multiplier impact of $56 is created within Massachusetts, according to the study.

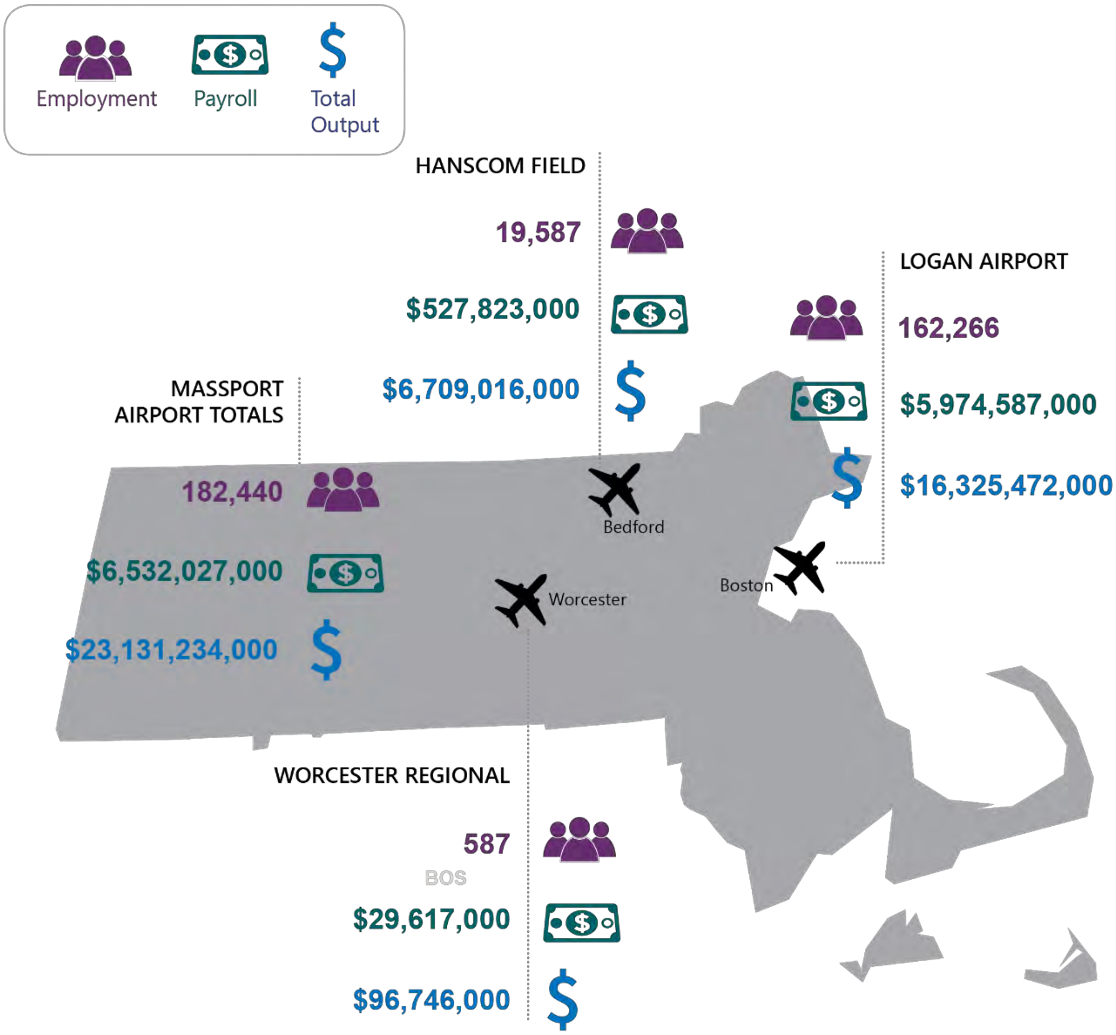
Massachusetts Statewide Airport Economic Impact Study Update, Report Cover. Source: MassDOT

While the economic impact of the region's airports was the focus of the study, it also noted qualitative benefits of the State's airports including:

- Providing police support and partnerships with first responders;
- Improving unmanned aircraft systems activities and training curriculums;
- Supporting aerial surveying, photography, and inspection operations;
- Conducting search-and-rescue operations;
- Supporting the U.S. military and other government operations;
- Prompting tenants/private developers to fund new airport infrastructure; and
- Stimulating workforce development challenges in the aviation industry.

10 U.S. Chamber of Commerce Foundation and 1776. 2017. *Innovation That Matters*.
11 U.S. Bureau of Economic Analysis. 2019. Gross Domestic Product by State, Fourth Quarter and Annual 2018.
12 U.S. Bureau of Economic Analysis. 2019. Real Gross Domestic Product and Related Measures: Percent Change from Preceding Period.
13 MassDOT. 2019. *Massachusetts Statewide Airport Economic Impact Study Update*. https://www.mass.gov/files/documents/2019/03/25/AeroEcon_ImpactStudy_January2019.pdf.
14 Multiplier effects refer to the recirculation of money in the local economy after initially being spent by the Airport, its tenants, or tourists. This recirculation increases the overall impact of the Airport's operation in the local economy.
15 MassDOT. 2019. *Massachusetts Statewide Airport Economic Impact Study Update*. https://www.mass.gov/files/documents/2019/03/25/AeroEcon_ImpactStudy_January2019.pdf.

Figure 4-5 Total Economic Impact of Massport Airports



Source: MassDOT, Massachusetts Statewide Airport Economic Impact Study Update, 2019.
Notes: "Massachusetts Totals" refers to the total economic output of all Massachusetts airports.

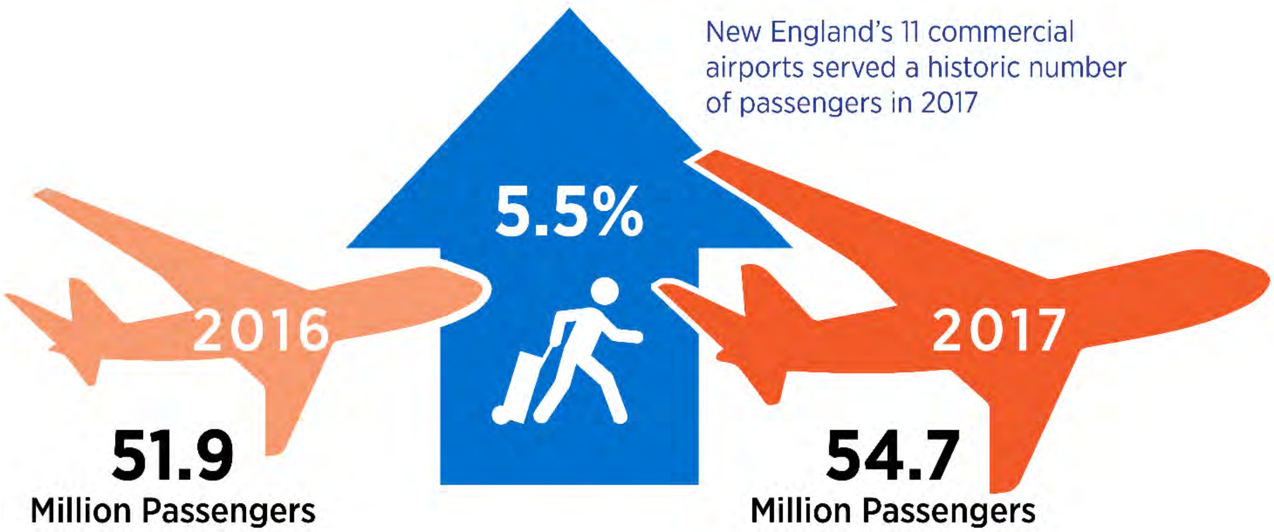
New England Regional Trends

Since 2000, as overall national and regional passenger activity levels have increased, aircraft operation activity levels have declined substantially due to trends of larger aircraft size, higher aircraft load factors, and reduced service in less profitable markets. The total number of aircraft operations at regional airports declined from 1.6 million in 2000 to 1.0 million in 2017.

Air Passenger Trends

Overall, passenger traffic at the New England airports grew at a higher rate than the overall U.S. air passenger market.[16] This New England passenger growth reflected increases at some New England regional airports and Logan Airport (**Figure 4-6**). Nationally, U.S. passenger traffic exceeded pre-2008/2009 recession levels in 2014, then continued to show growth and reached a new peak in 2017.

Figure 4-6 Passenger Activity at Logan Airport and Regional Airports in 2016 and 2017

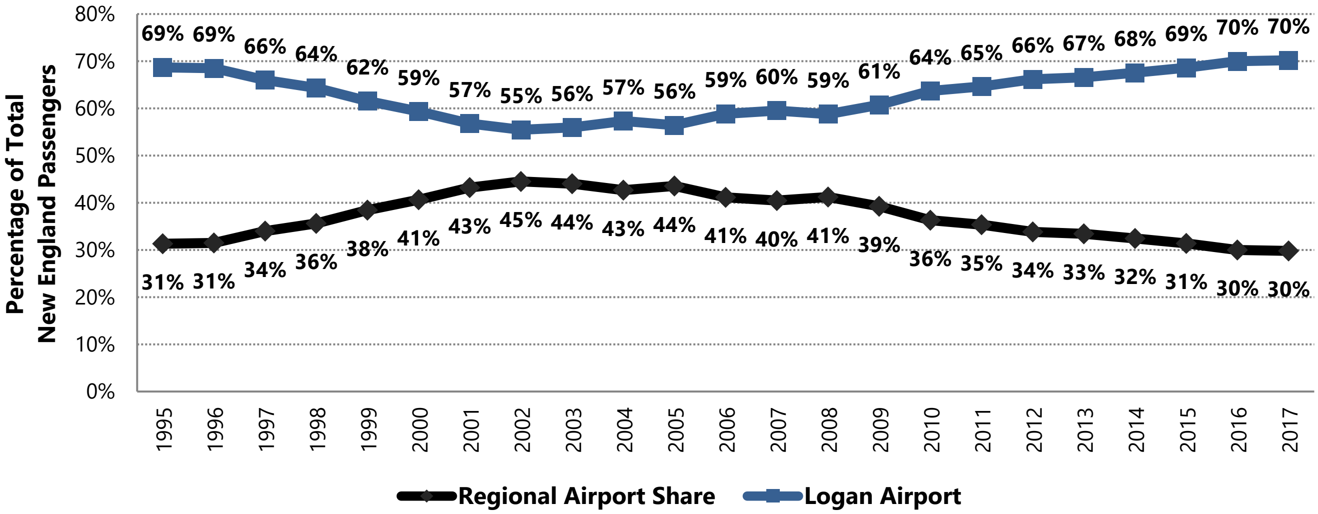


Source: VHB; Massport and individual airport data reports.

Logan Airport continued to drive passenger traffic growth in the New England region. In 2017, Logan Airport saw passenger growth of 5.8 percent compared to 2016, while total passenger traffic at other New England airports increased by only 4.6 percent. The 10 regional airports accounted for a total of 16.3 million passengers in 2017, compared to 15.6 million passengers in 2016, due largely to Allegiant Air's 65-percent increase in service offerings at Portsmouth International Airport. The 10 regional airports' share of total New England passengers decreased to 29.8 percent in 2017, compared to 30 percent in 2016 (see **Table 4-2** and **Figure 4-7**). The decline in passenger share at the regional airports in recent years reflects the growth of services by low-cost carriers at Logan Airport and the reduction in industry-wide capacity from secondary and tertiary airports. Between 2000 and 2011, passenger traffic at secondary airports declined at an average annual rate of 1.7 percent and increased at a slower rate of 0.5 percent per year from 2011 and 2017. The regional airport passenger share decreased from 41.1 percent in 2006 to 29.8 percent in 2017 as low-fare options became available at Logan Airport and regional airports offered limited services.

16 U.S. Department of Transportation. 2017. Bureau of Transportation Statistics for Total U.S. Scheduled Passenger Traffic.

Figure 4-7 Logan Airport's and Regional Airports' Share of New England Passengers, 1995-2017



Source: Massport and individual airport data reports.

Apart from Hanscom Field and Worcester Regional Airport, the regional airports closest to Logan Airport are T.F. Green Airport in Warwick, Rhode Island and Manchester-Boston Regional Airport in Manchester, New Hampshire. Because of their proximity to Logan Airport and overlapping market areas, these airports may be convenient choices for some passengers in the Greater Boston Area.

Logan Airport is well-positioned in terms of access, competitive airfares, and available air services to meet the demands of the core Boston air passenger market. Passenger traffic at T.F. Green Airport and Manchester-Boston Regional Airport peaked in 2005. After the 2005 peak, there was an industry-wide trend of airline service reductions at smaller airports. The number of passengers at T.F. Green Airport increased by 7.9 percent in 2017, compared to 2016, while the number of passengers at Manchester-Boston Regional Airport decreased by 2.5 percent. T.F. Green Airport and Manchester-Boston Regional Airport remain well situated to serve their own catchment areas.

In 2017, the two airports served 13.3 percent (5.9 million) of the combined passengers at the three main commercial airports serving the Greater Boston area, down from 13.6 percent (5.7 million) in 2016 and a high share of 27.9 percent (8.8 million) in 2002. **Figure 4-8** depicts the historical distribution of air passengers using Logan Airport, T.F. Green Airport, and Manchester-Boston Regional Airport.

Table 4-2 Passenger Activity at New England Regional Airports and Logan Airport, 2000, 2010-2017

	Passenger Levels (millions)[1]									Percent Change
Airport	**2000**	**2010**	**2011[2]**	**2012[2]**	**2013[2]**	**2014[2]**	**2015[2]**	**2016[2]**	**2017[2]**	**(2016-2017)**
Bradley International, CT	7.34	5.34	5.61	5.38	5.42	5.88	5.93	6.06	6.44	6.3%
T.F. Green, RI	5.43	3.94	3.88	3.65	3.80	3.57	3.57	3.65	3.94	7.9%
Manchester-Boston Regional, NH	3.17	2.81	2.71	2.45	2.42	2.10	2.08	2.02	1.97	(2.5%)
Portland International Jetport, NH	1.34	1.71	1.68	1.62	1.68	1.67	1.73	1.79	1.86	3.9%
Burlington International, VT	0.90	1.30	1.29	1.25	1.23	1.22	1.19	1.21	1.18	(2.5%)
Bangor International, ME	0.38	0.39	0.43	0.46	0.48	0.49	0.54	0.55	0.53	(3.4%)
Worcester Regional, MA	0.11	0.07	0.11	0.03	0.02	0.12	0.12	0.12	0.11	(5.7%)
Portsmouth International, NH	0.07	0.00[3]	0.01	0.03	0.04	0.09	0.09	0.13	0.19	46.2%
Tweed-New Haven Regional, CT	0.08	0.07	0.08	0.08	0.07	0.07	0.07	0.06	0.06	1.6%
Hanscom Field, MA[4]	0.16	0.00[3]	0.01	0.01	0.0[3]	0.0[3]	0.0[3]	0.0[3]	0.0[3]	0.0%
Regional Subtotal	**18.98**	**15.63**	**15.80**	**14.95**	**15.17**	**15.19**	**15.30**	**15.58**	**16.29**	**4.6%**
Logan Airport	**27.73**	**27.43**	**28.91**	**29.24**	**30.22**	**31.63**	**33.45**	**36.29**	**38.41**	**5.9%**
Total	**46.71**	**43.06**	**44.71**	**44.19**	**45.39**	**46.82**	**48.75**	**51.87**	**54.70**	**5.5%**

Source: Massport and individual airport data reports. Tweed-New Haven Regional Airport is based on U.S. Department of Transportation, T-100 Database.

Notes: Data for Logan Airport includes domestic, international, and general aviation passengers.
Numbers in parentheses ( ) indicate negative numbers.

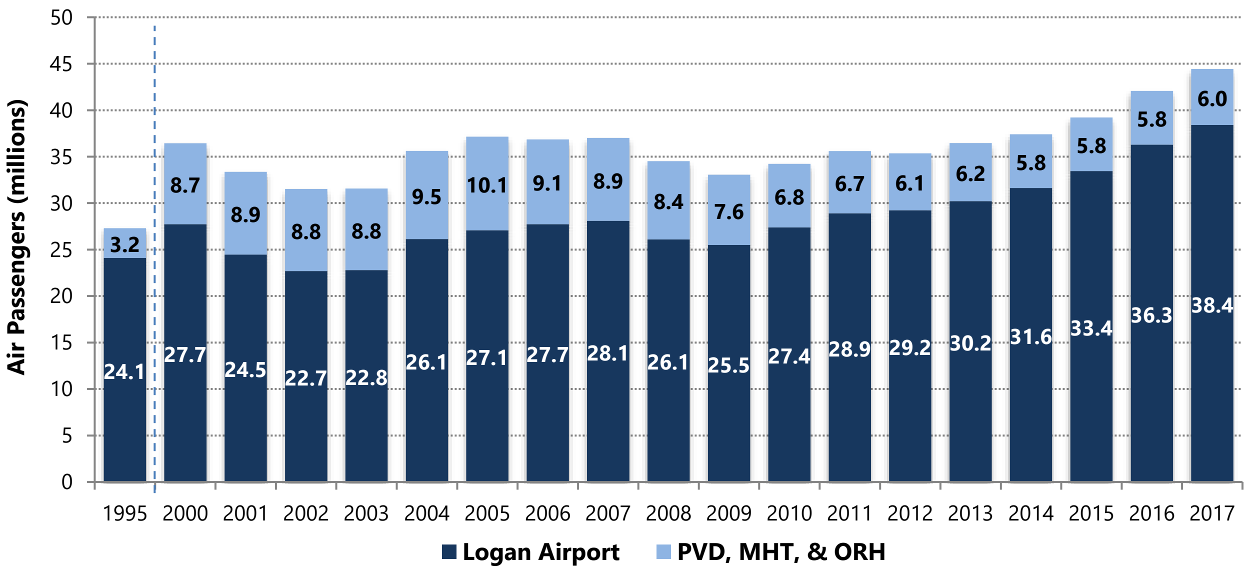
1 All passengers in millions. Passenger levels are enplaned plus deplaned passengers (where available) or enplaned passengers times two.

2 Reflects most updated passenger statistics for Burlington International, Bangor International, and Portsmouth International airports based on latest available airport records as of December 2018.

3 Indicates fewer than 5,000, but more than zero, scheduled commercial passengers.

4 Hanscom Field also reported annual non-scheduled passenger enplanements above 10,000 between 2011 and 2017.

Figure 4-8 Passenger Activity Levels at Logan Airport (BOS) and T.F. Green (PVD), Manchester-Boston Regional (MHT), and Worcester Regional (ORH) Airports, 1995, 2000-2017



Source: Massport and individual airport data reports.

Aircraft Operation Trends

As shown in **Table 4-3**, total aircraft operations in the New England region (including Logan Airport) saw a decline of 0.2 percent in 2017, from 1,017,597 operations in 2016[17] to 1,015,591 operations in 2017. An increase in aircraft operations at Logan Airport was accompanied by an overall decrease in aircraft operations at the 10 regional airports. Total aircraft operations at Logan Airport in 2017 increased by 2.6 percent (an increase of 10,149 operations), compared to 2016, while total operations at the regional airports decreased by 1.9 percent (a decrease of 12,115 operations).

Commercial operations in the New England region increased from 2016 to 2017 due to airlines gradually increasing capacity and services in more profitable markets, such as the Boston Metropolitan Area. These trends are seen across the industry. In 2017, total U.S. air carrier activity increased by 3.2 percent over 2016,[18] while total U.S. air passenger traffic increased by 3.1 percent year-over-year.[19]

Combined GA operations in the New England region decreased in 2017 compared to 2016. This decrease can be partially attributed to the increase in crude oil prices in 2017, which resulted in increased jet fuel prices. Fuel costs usually account for a more significant portion of GA aircraft operating costs, compared to commercial airlines. GA operations continue to be the dominant type of aircraft activity at the regional airports. GA represents only 7.8 percent of aircraft activity at Logan Airport, which primarily accommodates the region's domestic and international commercial airline operations.

17 Reflects updated CY 2016 aircraft operation statistics for some regional airports based on updated Federal Aviation Administration tower counts since the publication of the 2016 EDR. See Table 4-3 for more details.

18 Federal Aviation Administration (FAA). 2016. FAA Aerospace Forecast Fiscal Years 2017-2037. https://www.faa.gov/data_research/aviation/aerospace_forecasts/.

19 U.S. Department of Transportation. 2017. Bureau of Transportation Statistics for Total U.S. Scheduled Passenger Traffic.

Overall, the regional airports accommodated a much greater share of the region's aircraft operations than their share of air passengers due to high levels of GA traffic. In 2017, the regional airports accounted for 29.8 percent of the region's passenger traffic, but 60.5 percent of aircraft activity. On average, there were approximately 26.5 passengers per aircraft operation at the regional airports, compared to 95.7 passengers per operation at Logan Airport in 2017, largely reflecting aircraft sizes.

Total aircraft operations in the region in 2017 were well below the region's level of aircraft operations in 2000. Total aircraft operations decreased by approximately 36.6 percent, falling from approximately 1.6 million operations in 2000 to 1.0 million operations in 2017. There were similarly large reductions in all three categories of activity: commercial, GA, and military. Several factors have contributed to the declining trend in commercial airline operations, including a shift to larger capacity aircraft, higher passenger load factors, and a concurrent reduction in airline services at smaller regional airports. Factors negatively affecting GA activity include increased fuel prices through the past decade and a declining private pilot base. Military operations have also declined, consistent with nationwide trends.

Table 4-3 Aircraft Operations by Classification for New England's Airports, 2000, 2016, and 2017

	2000				2016				2017			
Airport	**Commercial[1]**	**GA[2]**	**Military[2]**	**Total**	**Commercial[1]**	**GA[2]**	**Military[2]**	**Total**	**Commercial[1]**	**GA[2]**	**Military[2]**	**Total**
Bradley International	132,062	31,863	5,811	169,736	77,174	14,460	3,178	**94,812**	78,435	13,233	3,006	**94,674**
T.F. Green	103,750	52,184	2,764	158,698	43,659	26,032	397	**70,088**	45,831	26,274	490	**72,595**
Manchester-Boston Regional	61,506	45,740	586	107,832	40,589	14,447	501	**55,537**	37,850	13,169	697	**51,716**
Portland International Jetport	47,609	56,571	2,072	106,252	32,171	18,334	488	**50,993**	32,845	18,392	568	**51,805**
Burlington	45,745	59,377	10,241	115,363	26,405	38,614	6,114	**71,133**	26,684	34,386	5,080	**66,150**
Bangor	21,446	34,831	26,507	82,784	14,603	16,815	11,271	**42,689**	15,874	17,157	9,985	**43,016**
Portsmouth International	6,104	31,601	9,973	47,678	9,435	29,043	8,913	**47,391**	9,597	31,555	8,150	**49,302**
Tweed-New Haven	5,260	56,200	328	61,788	7,195	28,811	683	**36,689**	6,820	18,389	574	**25,783**
Worcester Regional	4,029	46,518	495	51,042	2,616	31,858	780	**35,254**	2,925	26,332	850	**30,107**
Hanscom Field	6,572	204,512	1,287	212,371	266	120,891	632	**121,789**	295[3]	128,018[4]	759[4]	**129,072**
Subtotal	**434,083**	**619,397**	**60,064**	**1,113,544**	**254,113**	**339,305**	**32,957**	**626,375**	**257,156**	**326,905**	**30,159**	**614,220**
Logan Airport	452,763	35,233	0	487,996	360,442	30,780	N/A	**391,222**	370,251	31,120	N/A	**401,371**
Total	**886,846**	**654,630**	**60,064**	**1,601,540**	**614,555**	**370,085**	**32,957**	**1,017,597**	**627,407**	**358,025**	**30,159**	**1,015,591**

	Percent Change (2000-2017)				Percent Change (2016-2017)			
Airport	**Commercial[1]**	**GA[2]**	**Military[2]**	**Total**	**Commercial[1]**	**GA[2]**	**Military[2]**	**Total**
Bradley International	**(40.6%)**	**(58.5%)**	**(48.3%)**	**(44.2%)**	**1.6%**	**(8.5%)**	**(5.4%)**	**(0.1%)**
T.F. Green	**(55.8%)**	**(49.7%)**	**(82.3%)**	**(54.3%)**	**5.0%**	**0.9%**	**23.4%**	**3.6%**
Manchester-Boston Regional	**(38.5%)**	**(71.2%)**	**18.9%**	**(52.0%)**	**(6.7%)**	**(8.8%)**	**39.1%**	**(6.9%)**
Portland International Jetport	**(31.0%)**	**(67.5%)**	**(72.6%)**	**(51.2%)**	**2.1%**	**0.3%**	**16.4%**	**1.6%**
Burlington	**(41.7%)**	**(42.1%)**	**(50.4%)**	**(42.7%)**	**1.1%**	**(10.9%)**	**(16.9%)**	**(7.0%)**
Bangor	**(26.0%)**	**(50.7%)**	**(62.3%)**	**(48.0%)**	**8.7%**	**2.0%**	**(11.4%)**	**0.8%**
Portsmouth International	**57.2%**	**(0.1%)**	**(18.3%)**	**3.4%**	**1.7%**	**8.6%**	**(8.6%)**	**4.0%**
Tweed-New Haven	**29.7%**	**(67.3%)**	**75.0%**	**(58.3%)**	**(5.2%)**	**(36.2%)**	**(16.0%)**	**(29.7%)**
Worcester Regional	**(27.4%)**	**(43.4%)**	**71.7%**	**(41.0%)**	**11.8%**	**(17.3%)**	**9.0%**	**(14.6%)**
Hanscom Field	**(95.5%)**	**(37.4%)**	**(41.0%)**	**(39.2%)**	**10.9%**	**5.9%**	**20.1%**	**6.0%**
Subtotal	**(40.8%)**	**(47.2%)**	**(49.8%)**	**(44.8%)**	**1.2%**	**(3.7%)**	**(8.5%)**	**(1.9%)**
Logan Airport	**(18.2%)**	**(11.7%)**	**0.0%**	**(17.8%)**	**2.7%**	**1.1%**	**0.0%**	**2.6%**
Total	**(29.3%)**	**(45.3%)**	**(50.1%)**	**(36.6%)**	**2.1%**	**(3.3%)**	**(9.0%)**	**(0.2%)**

Sources: Federal Aviation Administration (FAA) tower counts; Massport and individual airport data reports.

Notes: Ranked by commercial operations. FAA tower counts used for all airports except Logan Airport and Portsmouth International.
Numbers in parentheses ( ) indicate negative numbers.
GA – General Aviation

1 May include some Air Taxi operations by fractional jet operators. FAA tower counts combine some fractional jet operations with small regional/commuter airline operations.
2 Includes itinerant and local operations at the regional airports. Military operations at Logan Airport are negligible and not included in Massport counts.
3 Value represents non-scheduled commercial activity.
4 Values sourced from *2017 L. G. Hanscom Field Environmental Status & Planning Report*.

Airline Passenger Service in 2017

Airlines can adjust service at an airport or on a specific route in two ways: by increasing or decreasing the number of flights operated and/or changing the size of the aircraft flown on the route. Changes in flight frequency and in aircraft size affect the number of seats available to passengers, also known as seat capacity. Airline services are therefore discussed in terms of seat capacity as well as the number of flight departures.[20] This section examines changes in airline departures and seat capacity and provides an overview of new and discontinued routes at the regional airports in 2017.

Service Developments at the Regional Airports

In 2017, a total of 16 airlines provided scheduled passenger service from the 10 regional airports to 47 non-stop markets.[21] Bradley International Airport, T.F. Green Airport, Portland International Jetport, and Portsmouth International Airport saw an increase in scheduled commercial services in 2017, while some of the other airports experienced service declines. The steep airline service cuts seen after 2007 due to the 2008/2009 economic recession and high fuel prices have largely come to an end. However, airlines continue to be conservative in growing capacity and continue to reduce frequencies on less profitable routes.

Table 4-4 shows the share of scheduled domestic departures for Logan Airport and the 10 regional airports for the August peak travel month from 2010 to 2017. In 2017, Logan Airport accounted for 62.8 percent of domestic departures in the New England region with 3,368 weekly departures during the month of August. Overall, the regional airports' combined share of scheduled domestic departures in the New England region increased from 36.9 percent in 2016 to 37.2 percent in 2017 (**Table 4-4**). Details of scheduled passenger operations by market and carrier for the regional airports for the years 2000 to 2017 are presented in Appendix F, *Regional Transportation*.

20 A departure is an aircraft take-off at an airport. While aircraft operations include both departures and arrivals, airline services are typically described in terms of departures, as the number of scheduled departures generally equals the number of scheduled arrivals. Changes in departures translate to changes in overall operations.

21 Includes Allegiant Air, which serves Bangor International Airport (Orlando/Sanford and St. Petersburg/Clearwater service), Burlington International Airport (Orlando/Sanford service), T.F. Green Airport (Cincinnati, Punta Gorda, and St. Petersburg/Clearwater service), and Portsmouth International Airport (Fort Lauderdale, Myrtle Beach, Punta Gorda, St. Petersburg/Clearwater and Orlando/Sanford service).

Table 4-4 Share of Scheduled Domestic Departures – Logan Airport and the 10 Regional Airports, 2010-2017 (for August peak travel month)

	2010	2011	2012	2013	2014	2015	2016	2017
Logan Airport	57.4%	57.2%	59.3%	60.6%	60.6%	62.5%	63.1%	62.8%
Bangor International Airport; Bradley International Airport; Burlington International Airport; Hanscom Field; Manchester-Boston Regional Airport; Portland International Jetport; Portsmouth International Airport; T.F. Green Airport; Tweed-New Haven Airport; Worcester Regional Airport	42.6%	42.8%	40.7%	39.4%	39.4%	37.5%	36.9%	37.2%

Sources: OAG Schedules; U.S. Department of Transportation T-100 Database.
Notes: Dataset and database changes may result in discrepancies with past environmental filings.
Allegiant Air does not report to OAG; Allegiant Air average weekly scheduled departures from T-100.
No scheduled domestic services reported at Hanscom Field.

Worcester Regional Airport (ORH)

Worcester Regional Airport is located in Worcester and Leicester (central Massachusetts), approximately 50 miles west of Logan Airport. Worcester Regional Airport is an important aviation resource that accommodates both corporate GA activity and limited commercial airline services. Massport assumed operation of Worcester Regional Airport in 2000 and later acquired the airport from the City of Worcester in June 2010.

Massport continues to invest in Worcester Regional Airport by modernizing the airport to serve better the commercial airline travel demands of the central Massachusetts region. Together with the City of Worcester, Massport has already initiated a 10-year, $100 million investment to revitalize and attract commercial operations to Worcester Regional Airport. Massport, in conjunction with the City of Worcester and other community stakeholders, actively promoted the reintroduction of scheduled airline service at Worcester Regional Airport and successfully secured new service provided by jetBlue Airways, including non-stop service to Orlando International and Fort Lauderdale-Hollywood airports. This service has proven to be highly popular, with jetBlue Airways achieving consistently high load factors (over 78 percent in 2017[22]) and handling 145,030 passengers in 2018. As a result of this collaboration, jetBlue Airways has already handled over 600,000 passengers at Worcester Regional Airport since commencing operations in late 2013.

Passenger and Operation Trends

Worcester Regional Airport has experienced consecutive commercial passenger growth at an average rate of 30 percent per year since 2013, serving a cumulative total of over 600,000 commercial air passengers through jetBlue Airways (**Figure 4-9**). From 2017 to 2018 alone, Worcester Regional Airport saw passenger numbers

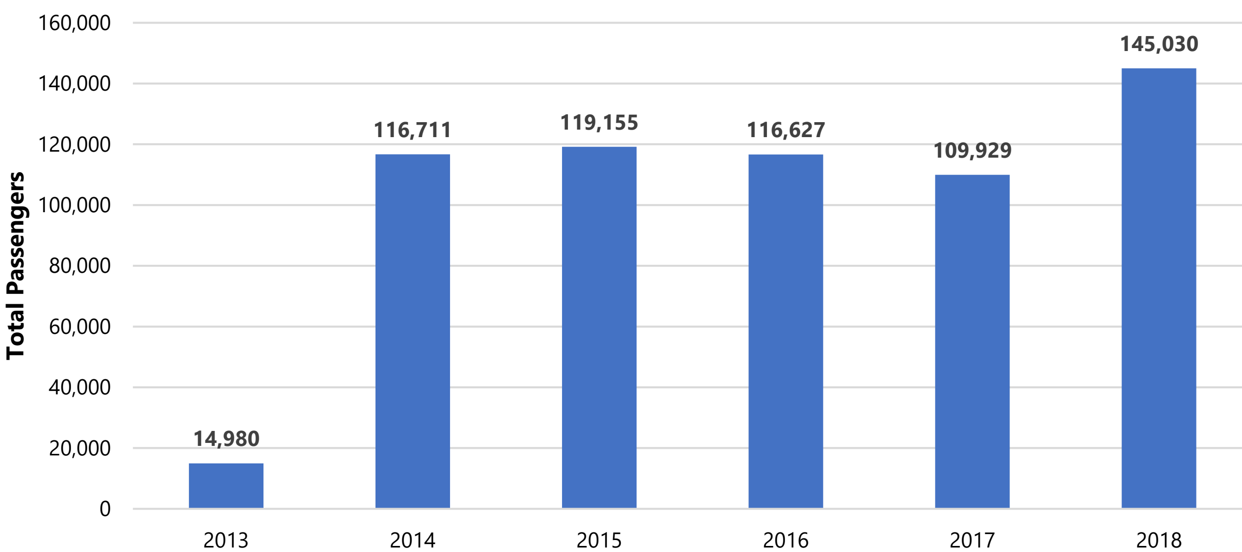
22 jetBlue Airways services at Worcester Regional Airport had an average load factor of 84 percent in 2015, 81 percent in 2016, and 78 percent in 2017 (U.S. Department of Transportation, T-100 Database).

increase by approximately 32 percent. Although commercial air passenger numbers have increased, GA operations and passengers have decreased. While commercial passenger numbers increased, Worcester Regional Airport experienced a decline in overall passenger activity of 5.7 percent from 2016 to 2017, primarily due to the decrease in GA and charter activity. Aircraft operations declined by 17.3 percent (**Table 4-2** and **Table 4-3**).

jetBlue E-190 aircraft at Worcester Regional Airport.
Source: Massport.

Aircraft operations at Worcester Regional Airport totaled 30,107 in 2017, with GA accounting for over 87 percent of aircraft activity. Commercial and military[23] aircraft operations increased from 2016 to 2017, while GA operations decreased (**Table 4-3)**. Overall, aircraft operations decreased by 14.6 percent from 2016 to 2017, and from 35,254 operations in 2016 to 30,107 operations in 2017. From 2000 to 2017, aircraft operations decreased by 41 percent, in large part due to the reduction in GA operations.

Figure 4-9 Passenger Activity at Worcester Regional Airport, 2013–2018



Source: Massport.

Service Developments

Worcester Regional Airport is currently served by jetBlue Airways with non-stop service to Fort Lauderdale and Orlando. Prior to the entry of jetBlue Airways, Worcester Regional Airport was served only by Direct Air, which operated regularly scheduled charter services from 2008 to 2012. When Direct Air filed for Chapter 7 bankruptcy in April 2012, Worcester Regional Airport no longer provided commercial service. After Direct Air ceased operations, Worcester Regional Airport returned to commercial service, initially with two daily

23 Includes itinerant and local operations. "Itinerant" represents operations that arrive from outside the traffic pattern or depart from the airport traffic pattern. "Local" represents operations that stay within the traffic pattern airspace (non-itinerant). Definitions from FAA.

scheduled departures operated by jetBlue Airways. In 2018, Worcester Regional Airport saw an average of three daily departures with the inclusion of American Airlines service (detailed below). According to advance OAG schedule data for August 2019, the Airport will average five daily departures once Delta Air Lines commences its Detroit route.

Massport, in conjunction with the City of Worcester and other community stakeholders, actively promoted the reintroduction of scheduled airline service at Worcester Regional Airport and successfully secured new service provided by jetBlue Airways. In November 2013, jetBlue Airways commenced non-stop services to Orlando International and Fort Lauderdale-Hollywood airports using 100-seat Embraer 190 aircraft. In 2017, jetBlue Airways maintained daily service on 100-seat Embraer 190 aircraft to Fort Lauderdale and Orlando, with no change in operations from 2016. In February 2017, jetBlue Airways announced daily service to New York JFK, which commenced in May 2018 following the recent completion of the CAT III Instrument Landing System (see below).

As of October 2018, additional carriers offer commercial passenger service from Worcester Regional Airport. American Airlines began offering flights to Philadelphia International Airport in October 2018 and Delta Air Lines will offer flights to Detroit Metropolitan Airport beginning in August 2019.

Facility Improvements

As mentioned above, Massport, in collaboration with the City of Worcester and with the use of Federal grants, has already initiated a 10-year, $100 million investment to revitalize and grow commercial operations at Worcester Regional Airport. Massport is committed to the long-term support of Worcester Regional Airport as demonstrated by the following initiatives:

- Massport recently completed construction of Worcester Regional Airport's CAT III Instrument Landing System, which will improve operational conditions and enhance safety to a level equal to that of all other commercial airports in New England. These improvements allow aircraft to land on Runway 11 during virtually all weather conditions. The CAT III system became fully operational after Federal Aviation Administration (FAA) certification in March 2018.
  - This project significantly improves Worcester Regional Airport's all-weather reliability, a long-standing impediment to greater utilization of this airport. The announced addition of new service to New York and two major airline hubs in the next several years reflects the impact of this investment.
  - This project included upgrading the Runway 11 Instrument Landing System from a CAT I to a CAT III system, and its associated required infrastructure and navigation aids, along with a partial parallel taxiway.

CAT III Instrument Landing System.
Source: Massport.

- Massport received a $2 million federal grant for two jet passenger boarding bridges through the FAA's Airport Improvement Program. The jet bridges will include ground power and preconditioned air for gates 3 and 4 in the commercial terminal building, which add environmental benefits by protecting air quality and conserving fuel.

- In January 2012, Massport approved a proposal by Rectrix Commercial Aviation Services, Inc. ("Rectrix")—which was recently acquired by Ross Aviation[24] in February 2019—to develop an aircraft hangar and office space at Worcester Regional Airport. The project included 27,000 square feet of hangar and office space that house large corporate jets and a regional aircraft maintenance facility. Ross Aviation offers private jet charters and fixed base operator (FBO) services, including transient aircraft parking and fueling services, from the new facility. Construction (started by Rectrix entity) was completed in November 2015. According to construction plans outlined in early 2019, the construction of a replacement fuel storage center ("fuel farm") will commence in 2019. Located near the hangars, the new fuel farm will make the availability of fuel for airlines and private jets more reliable.

Hanscom Field (BED)

Located in Bedford, Massachusetts, approximately 20 miles northwest of Logan Airport, Hanscom Field is New England's premier facility for business/corporate aviation. Hanscom Field is a full-service GA airport that serves a critical role as a GA reliever airport for Logan Airport by accommodating a wide variety of GA activities, including corporate aviation, private flying, commuter air services, as well as charters and light cargo.

In 2017, Hanscom Field accommodated 128,018 GA operations, approximately four times the number of GA operations that occurred at Logan Airport. Consistent with Hanscom Field's role as a premier corporate airport, new hangars are being built to accommodate the need for corporate jet services. In addition to its role as a GA facility, in the past, Hanscom Field has also accommodated niche scheduled commercial airline services.

Passenger and Operation Trends

Passenger activity[25] at Hanscom Field is currently limited to non-scheduled passenger service, primarily because of charter flight operations. Total passenger activity has remained relatively consistent since 2013 (**Table 4-2**). Overall, aircraft operations increased by 5.6 percent, from 121,789 in 2016 to 129,072 in 2017. Commercial, GA, and military operations all increased from 2016 to 2017 (**Table 4-3**). From 2000 to 2017, aircraft operations at Hanscom Field decreased by 39.2 percent.

Facility Improvements

Massport continues to invest in Hanscom Field to improve and upgrade facilities and maintain a safe, secure, and efficient airport. Past and future capital investments ensure that Hanscom Field can continue to serve its role as a GA reliever to Logan Airport as well as a premier business aviation facility for the region. In FY 2017, Massport invested $4.3 million in airfield, terminal, equipment, and other facility improvements at Hanscom Field. These airport improvement projects are summarized in the annual reports on *The State of Hanscom*.[26]

Massport's recently completed and ongoing capital investment projects at Hanscom Field include:

- Rehabilitation of Runway 11/29 and Runway 23 safety area, beyond the runway end, and a portion of Taxiway Juliet, south of Taxiway Tango.

24 Ross Aviation already has fixed-base operations at airports in Alaska, California, Arizona, New York, and the Cayman Islands. Ross-Rectrix Aviation is now the fixed-base operator at Worcester Regional Airport, Hanscom Field, Westfield-Barnes, and Barnstable Municipal Airports in Massachusetts.

25 Passenger activity reports on "non-scheduled" passenger enplanements. There was no "scheduled" service or passenger activity at Hanscom Field.

26 Massport. April 2018. *The State of Hanscom*. http://www.massport.com/media/2784/stateofhanscom-2017.pdf.

- Ongoing removal of vegetation obstructions on all four runway ends using recommendations in the 2014 to 2018 and 2019 to 2023 *Vegetation Management Plan* updates.
- Construction of a new Airport Rescue and Firefighting Facility (ARFF) and U.S. Customs and Border Protection (CBP) permanent facility, which opened in May 2019.
- Initiation of Massport Fire-Rescue operations in November 2015.
- Continued implementation of all aspects of Massport's *Wildlife Hazard Management Plan* for BED.
- Replacement of the field maintenance garage roof, which had reached the end of its useful life.

Upcoming projects at Hanscom Field include:

- Periodic replacement of T-Hangars in the terminal area;
- Improvements to airfield drainage;
- Updates to aging infrastructure, including new corporate hangars and new Boston MedFlight hangar, and plans for replacement of hangars in the Pine Hill area and North Airfield; and
- An Airfield Geometry Study.

In addition to Massport's investments, the Authority solicits third-party development of facilities that support and enhance Hanscom Field's role in the regional transportation system. Many of the hangars at Hanscom Field are owned or leased by tenants who are responsible for maintaining them. Ongoing third-party projects at Hanscom Field are listed below.

- In 2015, Jet Aviation began construction for a replacement Hangar 17, which includes two parking lots, an access road, and underground infrastructure to support the new parking lots. In 2016, Jet Aviation completed construction of the hangar, FBO, and apron.
- In 2015, the lease for Hangar 12A expired. Massport issued a Request for Proposal (RFP) for the redevelopment of the parcel and, in 2016, accepted a proposal from Boston MedFlight. In 2017, Boston MedFlight began construction activities to re-develop Hangar 12A and completed construction of its new Leadership in Energy and Environmental Design (LEED®) certified facility in November 2018, which is currently operating at BED.
- In 2017, Massport continued working with General Services Administration (GSA) to acquire a parcel of land north of the airfield, which was at that time owned by the U.S. Navy. In April 2018, Massport declined the transfer of the Navy property and the land was sold to Runway Reality Ventures, LLC for $9 million in a GSA auction.
- Massport issued an RFP in February of 2018 for redevelopment of a site immediately west of the Navy Hangar. An Environmental Assessment (EA) for development of the property was filed for up to 110,000 square feet of corporate hangar development at this location.
- In March 2019, Massport issued an RFP for design services associated with replacement of the Pine Hill T-Hangars to a 7-acre site west of the Navy Hangar. As planned, the development will construct 38 T-Hangars (up to 55,000 square feet) and supporting taxilane with construction starting in the spring of 2020 and lasting approximately 18 months.

Bradley International Airport (BDL)

In 2011, the Connecticut Airport Authority was established to oversee the operation and development of Bradley International Airport. The Connecticut Airport Authority, a quasi-public agency consisting of an 11-member board, manages day-to-day operations at Bradley International Airport, as well as at five GA airports in Connecticut (Danielson, Groton/New London, Hartford Brainard, Waterbury-Oxford, and Windham airports). The goal of the Connecticut Airport Authority is to transform Bradley International Airport and the five GA airports into economic drivers for the state. Bradley International Airport was previously run by a board under the Connecticut Department of Transportation (ConnDOT).

Passenger and Operation Trends

Passenger activity at Bradley International Airport increased by 6.3 percent from 2016 to 2017. This growth marks the sixth straight year of passenger traffic growth between 2012 and 2017. Compared to 2000, however, passenger activity has decreased by 12.3 percent (**Table 4-2**). Aircraft operations at Bradley International Airport decreased by 0.1 percent, from 94,812 in 2016 to 94,674 in 2017; commercial operations increased while GA and military operations decreased (**Table 4-3**). From 2000 to 2017, aircraft operations decreased by 44.2 percent.

Service Developments

Annual departing seat capacity at Bradley International Airport increased by 8.2 percent in 2017. The capacity increase was driven by additional air service by American Airlines (6.6 percent increase in seats, mostly driven by seats to Los Angeles), Air Canada (8.2 percent increase in seats, mostly driven by seats to Toronto), and Aer Lingus (362.7 percent increase in seats). In 2017, Spirit Airlines began service to Fort Lauderdale, Fort Myers, Myrtle Beach, Orlando, and Tampa; United Airlines to San Francisco; and Norwegian Air to Edinburgh, United Kingdom.

Facility Improvements

The Airport's $280-million capital improvement program for FY 2014 through FY 2018 includes the following projects:

- A consolidated rental car facility;
- Demolition of the Murphy Terminal;
- Roadway demolition and re-alignment;
- Utility relocation; and
- Airfield improvements.

In 2018, the airport revealed a $1.4-billion master plan that will take place within the next 20 years, which includes the following projects:

- New passenger Terminal B building;
- Reconfiguration of Schoephoester Road;
- Taxiway enhancement;
- New Baggage inspection/federal inspection service facility; and
- Additional parking.

T.F. Green Airport (PVD)

T.F. Green Airport, located in Warwick, Rhode Island, is the first state-owned and operated airport in the U.S. T.F. Green Airport is owned by the Rhode Island Airport Corporation (RIAC).

Passenger and Operation Trends

Passenger activity at T.F. Green Airport increased by 7.9 percent from 2016 to 2017. Aircraft operations increased by 3.6 percent, from 70,088 in 2016 to 72,595 in 2017 (**Table 4-3**); commercial, GA, and military operations all saw an increase. From 2000 to 2017, aircraft operations at T.F. Green Airport decreased by 54.3 percent. T.F. Green Airport remains well situated to serve its own catchment area.

Service Developments

T.F. Green Airport had an overall seat capacity increase of 11.3 percent in 2017. American Airlines, Azores Airlines (formerly SATA International), and Southwest Airlines increased available seat capacity at the airport, with Azores Airlines implementing the most significant increases on a year-over-year basis. Since September 2018, Azores Airlines left the Providence market, where it provided seasonal summer service to Ponta Delgada, Portugal. U.S. carrier Frontier Airlines currently provides service to Charlotte, Denver, Orlando, and Raleigh-Durham. New international carrier Norwegian Air Shuttle introduced service to Belfast, Cork, Dublin, and Shannon, Ireland; Bergen, Norway; Edinburgh, United Kingdom; Fort-de-France, Martinique; and Pointe-à-Pitre, Guadeloupe in 2017. However, as of May 2019 Innovata schedules, the only international markets served from T.F. Green are Toronto, Canada (Air Canada) and Dublin, Ireland (Norwegian Air).

Facility Improvements

In September 2011, the FAA issued a Record of Decision (ROD) approving the Preferred Alternative for the T.F. Green Airport Improvement Program, which entailed an extension to the airport’s main runway, Runway 5-23, to allow non-stop flights to the West Coast, runway safety area improvements on the crosswind runway, and other safety and efficiency projects. The crosswind runway safety area projects were substantially completed in 2015. Construction of the Runway 5-23 extension began in 2016 and was completed in December 2017. The Main Avenue relocation on the Runway 5 End, an enabling project for the runway extension, began in 2015 and was completed in 2016.

The following improvements were included in the Airport Improvement Program:

- Runway 16 End Safety Area improvements, which involved installation of Engineered Material Arresting System (EMAS), airfield electrical improvements on the Runway 16 end, and reconfiguration of the taxi lane from the northeast ramp to the Runway 16 end.
- Construction of the Runway 34 End Safety Area improvements, including EMAS construction at the Runway 34 End, partial reconstruction of Taxiway C, and construction of the associated airport service road.
- Runway 5 End extension. This project was completed by the end of 2017 and involved extension of the primary runway from its current length of 7,166 feet to 8,700 feet, which now allows for non-stop flights to West Coast destinations. The project also involved an extension of the parallel Taxiway M and construction of an EMAS at the Runway 5 end.
- Relocation of Winslow Park due to the Runway 5 extension. Work included replacement of the existing soccer and softball fields, playground facility, and concession and restroom facilities, as well as traffic calming measures and landscaping improvements.

Separate from the T.F. Green Airport Improvement Program, construction of a Deicer Management System, which allows for the collection and treatment of glycol used to de-ice aircraft at T.F. Green, began in 2013 and was put into operation in 2015. T.F. Green initiated a master planning process in 2018 that is continuing into 2019. Consideration is being given to landside access, parking, terminal facilities including gates, taxiway improvements, and other airport facilities.

Manchester-Boston Regional Airport (MHT)

Manchester-Boston Regional Airport is in Manchester, New Hampshire, less than 50 miles north of Boston, Massachusetts. The airport is owned by the City of Manchester with airport management consisting of a five-member board. By 2005, over 4 million passengers were using Manchester-Boston Regional Airport. However, the passenger level in 2017 declined to approximately 2 million passengers, returning to its 1999 level.

Passenger and Operation Trends

Passenger activity at Manchester-Boston Regional Airport decreased by 2.5 percent from 2016 to 2017 (**Table 4-2**). Overall, aircraft operations decreased by 6.9 percent, from 55,537 in 2016 to 51,716 in 2017; commercial and GA operations decreased from 2016 to 2017, while military operations increased (**Table 4-3**). From 2000 to 2017, aircraft operations at Manchester-Boston Regional Airport decreased by 52.0 percent.

Service Developments

Manchester-Boston Regional Airport saw an overall decline in departing seat capacity as United Airlines and Southwest Airlines reduced seat capacity by 11.3 percent and 6.5 percent, respectively, compared to 2016. American Airlines increased departing seats to Charlotte and decreased departing seats to Philadelphia and Washington D.C. Delta Air Lines increased seat capacity by 0.9 percent, adding frequencies to Atlanta and Detroit while reducing frequencies to New York LaGuardia.

Facility Improvements

Manchester-Boston Regional Airport completed an Airport Master Plan Update in 2011. The Airport Master Plan Update provides a blueprint for development and improvement of airport facilities and infrastructure through 2030. Recent and ongoing improvement projects at the airport include:

- The Terminal Ramp Replacement Project, to rehabilitate the concrete apron areas adjacent to the terminal building, began in 2012 and was completed in 2013.
- Demolition of structures in the runway protection zone (RPZ)[27] of Runway 06 to remove buildings with usages deemed non-compatible with RPZs, as defined by the FAA. Elements of the project include demolishing the Highlander Inn and Conference Center and associated buildings.
- Upgrades to the terminal building heating, ventilation, and air conditioning (HVAC) systems to address certain deficiencies in the terminal cooling system and provide significant improvements to customer comfort levels within areas of the terminal building.
- Parking Lot A access improvements.
- Overlay of a portion of Taxiway M.
- Reconstruction of Taxiway H pavement of approximately 1,200 feet.
- Relocation of Taxiway B stub to meet design standards.

Other potential projects over the coming years include: wireless network and support services; a rental car customer service facility; security checkpoint consolidation; operations and maintenance of the in-line baggage handling system, and a passenger boarding bridge.

Portland International Jetport (PWM)

Portland International Jetport, located in Portland, Maine, is owned by the City of Portland. Passenger activity and operations increased overall in 2017 compared to 2016. Portland International Airport also experienced an increase in seat capacity from jetBlue Airways, United Airlines, Southwest Airlines, and Delta Air Lines.

Passenger and Operation Trends

Passenger activity at Portland International Jetport increased by 3.9 percent from 2016 to 2017. Overall, aircraft operations increased by 1.6 percent, from 50,993 operations in 2016 to 51,805 operations in 2017 (**Table 4-3**). From 2000 to 2017, operations at Portland International Jetport decreased by 51.2 percent.

Service Developments

Portland International Jetport experienced a 5.7 percent increase in airline seat capacity in 2017 due to service increases by all airlines except Branson Air Express. American Airlines increased scheduled seats by 7.0 percent, adding frequencies in the Charlotte and Washington National markets. jetBlue, United Airlines, Southwest Airlines, and Delta Air Lines also increased seat capacity by 2.1 percent, 1.3 percent, 8.4 percent, and

27 A runway protection zone (RPZ) enhances the safety of the area beyond the end of the runway in the event of a landing or crash beyond the runway end. Only compatible land uses are permitted within an RPZ. Land uses prohibited from an RPZ include residences and places of public assembly.

6.1 percent, respectively. In 2017, Elite Airways increased seat capacity by 67.6 percent, adding new service to Halifax and ending services to Bar Harbor and Islip. Branson Air Express ended its Melbourne service in February 2016.

Burlington International Airport (BTV)

Burlington International Airport, located in Burlington, Vermont, is owned by the City of Burlington. It is a joint-use civil-military airport. Burlington International Airport experienced an overall decrease in passenger activity and operations, but an increase in airline seat capacity in 2017.

Passenger and Operation Trends

Passenger activity at Burlington International Airport decreased by 2.5 percent from 2016 to 2017. Overall, aircraft operations decreased by 7.0 percent, from 71,133 operations in 2016 to 66,150 operations in 2017. Commercial operations increased, while GA and military operations both decreased (**Table 4-3**). From 2000 to 2017, aircraft operations at Burlington International Airport decreased by 42.7 percent.

Service Developments

Burlington International Airport experienced an overall increase of 0.2 percent in airline seat capacity in 2017. jetBlue Airways, Porter Airlines, and American Airlines increased departing seat capacity at the airport, while Delta Air Lines, Allegiant Air, and United Airlines reduced departing seat capacity in 2017. Delta Air Lines reduced seat capacity by 2.5 percent, decreasing scheduled seats to Detroit and New York La Guardia. jetBlue Airways increased seat capacity and frequency in the New York JFK market. United Airlines decreased capacity to New York Newark, Chicago O'Hare, and Washington Dulles. Seasonal service to Toronto City Airport by Porter Airlines increased by 18.4 percent in scheduled departures. American Airlines increased overall seat capacity at Burlington by 1.2 percent in 2017. Allegiant Air ended its service to Orlando Sanford International Airport (Orlando/Sanford) in March 2017.

Burlington International Airport began the process of updating its Airport Master Plan, previously approved in 2012. The 2018 Master Plan update will provide an inventory of current facilities; present forecasts of growth; assess the need for additional development or rehabilitation of facilities; consider alternatives for future improvements; and provide a capital improvement plan.

Bangor International Airport (BGR)

Bangor International Airport is located in Bangor, Maine and is owned by the City of Bangor. Bangor International Airport passenger activity decreased while overall operations increased in 2017. Bangor International Airport also saw an overall seat capacity increase in 2017.

Passenger and Operation Trends

Passenger activity at Bangor International Airport decreased by 3.4 percent from 2016 to 2017. Overall, aircraft operations increased by 0.8 percent, from 42,689 operations in 2016 to 43,016 operations in 2017. Commercial and GA operations increased, while military operations decreased (**Table 4-3**). From 2000 to 2017, aircraft operations at Bangor International Airport decreased by 48.0 percent.

Service Developments

Bangor International Airport saw an overall seat capacity increase of 13.2 percent in 2017. United Airlines, Delta Airlines, and American Airlines all increased scheduled seats in 2017, while Allegiant Air decreased overall capacity at the airport. American Airlines introduced service to Charlotte, and Delta Air Lines discontinued service to Detroit. Allegiant Air decreased frequencies to Orlando/Sanford and St. Pete-Clearwater International Airport (St. Petersburg/Clearwater).

Tweed-New Haven Airport (HVN)

Tweed-New Haven Airport, located in New Haven, Connecticut, is managed by a six-member board and is operated by the Tweed-New Haven Airport Authority. Passenger activity increased while operations decreased in 2017. Tweed-New Haven Airport saw reduced departing frequencies from American Airlines in 2017.

Passenger and Operation Trends

Passenger activity at Tweed-New Haven Airport increased by 1.6 percent from 2016 to 2017 (**Table 4-2**). Overall, aircraft operations decreased by 29.7 percent, from 36,689 operations in 2016 to 25,783 operations in 2017 (**Table 4-3**). From 2000 to 2017, aircraft operations at Tweed-New Haven Airport decreased by 58.3 percent.

Service Developments

Tweed-New Haven Airport (CT) is served by a single commercial carrier. In 2017, Tweed-New Haven Airport saw reduced departing frequencies of 8.9 percent as American Airlines reduced service to Philadelphia, the only commercial market served from the airport.

Portsmouth International Airport (PSM)

Portsmouth International Airport, located in Portsmouth, NH, is operated by the Pease Development Authority. There have been $85 million in airfield infrastructure improvements in the past 15 years and a newly reconstructed 5.3-acre terminal apron.

Passenger and Operation Trends

Passenger activity at Portsmouth International Airport increased by 46.2 percent from 2016 to 2017 (**Table 4-2**). Overall, aircraft operations increased by 4.0 percent, from 47,391 operations in 2016 to 49,302 operations in 2017. Commercial and GA operations increased, while military operations decreased (**Table 4-3**). From 2000 to 2017, aircraft operations at Portsmouth International Airport increased by 3.4 percent.

Service Developments

The airport is served by a single commercial carrier. Portsmouth International Airport lost scheduled commercial service in 2008 when Allegiant Air discontinued services but regained commercial service in 2013 when Allegiant Air re-entered the market with non-stop service to Orlando/Sanford. Allegiant Air has continued to expand at the airport in recent years, adding Punta Gorda as a second destination in 2014, Fort Lauderdale

as a third destination in late 2015, and St. Petersburg/Clearwater in 2017. In 2017, seasonal service to Myrtle Beach was added. Seat capacity growth of 65.5 percent in 2017 was due to Allegiant Air's increased service.

Local and Regional Long-Range Transportation Planning

A balanced regional intermodal transportation network reduces reliance on Logan Airport as the region's primary transportation hub and provides New England travelers with a greater range of viable transportation options. This section highlights efforts to promote an integrated, multimodal regional transportation network through cooperative transportation planning among transportation agencies and concerned parties.

Massport plays a fundamental role within the transportation systems of the Boston metropolitan area and New England and supports an integrated multimodal transportation policy to improve the efficient use of transportation infrastructure on both a metropolitan and a regional scale. Logan Airport functions as New England's premier commercial airport, providing an essential connection between the New England states and the global economy. Recent studies have indicated that there is a significant lack of usable aviation capacity in the coastal mega-regions[28] (although not in Boston itself) and identified a need for access to alternative forms of short-distance travel across these regions.[29]

Because the construction of a second major Boston airport has been deemed impractical, high-speed rail is increasingly viewed as a potential complement in the regional transportation system and aviation planning.[30] Given the comparable travel times, proximity of service to downtown Boston, and the potential for highly efficient electrified propulsion, high-speed rail could provide intercity connectivity for city-pairs in a corridor up to 600 miles long that would be competitive with air travel.[31] Boston's South Station is undergoing planning and design for expansion that would support current and future rail mobility in Massachusetts and along the NEC, including future high-speed rail.

Boston and Statewide Long-Term Transportation Vision

The following sections describe long-term transportation initiatives that are part of the Boston and Statewide transportation vision. Where applicable, these sections highlight Massport's commitment to and involvement in the regional transportation system.

Long-Range Transportation Plan of the Boston Region Metropolitan Planning Organization (MPO)

In July 2015, the Boston MPO published its quadrennial long-range plan for the region and its transportation network, titled *Charting Progress to 2040*.[32] The Boston MPO is updating its Long-Range Transportation Plan, *Destination 2040*, to be adopted in the summer of 2019. The plan focuses on six goals: safety; preservation of

28 The coastal mega-regions are the continuously urbanized areas along the east and west coasts of the U.S. (Washington, DC, Philadelphia, New York City, Hartford, and Boston).

29 Federal Aviation Administration. 2007. *Capacity Needs in the National Airspace System 2007-2025* (commonly referred to as FACT-2). https://www.faa.gov/airports/resources/publications/reports/media/fact_2.pdf; Transportation Research Board. 2010. *ACRP Report 31: Innovative Approaches to Addressing Aviation Capacity Issues in Coastal Mega-regions*. http://rsginc.com/files/publications/24.RSG_ACRP_Report31.pdf.

30 Transportation Research Board. 2015. *ACRP 03-23: Integrating Aviation and Passenger Rail Planning*. https://crp.trb.org/acrp0715/acrp-report-118-integrating-aviation-and-passenger-rail-planning/.

31 America 2050. 2009. *Where High-Speed Rail Works Best.* http://www.america2050.org/pdf/Where-HSR-Works-Best.pdf.

32 Boston Region Metropolitan Planning Organization. *Charting Progress to 2040*. http://www.ctps.org/lrtp.

the existing system; capacity management/mobility; clean air/clean communities; transportation equity; and economic vitality. It envisions the use of new technology and prioritizes safety, equitable access, mobility, and varied transportation options.

The plan also envisions the Boston metropolitan region as a continuing economic, educational, and cultural hub that contributes to a high quality of life. A high quality of life is supported by a well-maintained transportation system with safe, healthy, affordable, efficient, and varied transportation options, which in turn increase access to educational opportunities, jobs, and services. Increased opportunities to use active or high-occupancy modes of transportation can also reduce emissions of greenhouse gases and other pollutants, improving air quality and reducing the overall environmental impact attributable to the transportation sector. This vision is possible through attentive maintenance, cost-effective management, and strategic investment in the region's transportation system.

As a member of the MPO Board, Massport is an active participant in the development of the Boston MPO's long-range transportation plan. The plan's vision is broad-based; more specifically for the Airport, the long-range vision finds that support for air cargo is critical.

Focus40

Focus40 is the 25-year investment plan for the Massachusetts Bay Transportation Authority (MBTA) to meet the needs of the Boston Region through the year 2040. The Focus 40 plan was released in draft form in March 2019. The plan considers all rapid transit, commuter rail, bus, ferry, and paratransit services.[33] The plan developed "a long-term investment strategy that recognizes both today's infrastructure challenges as well as the shifting demographics, changing climate, and evolving technologies that may collectively alter the role the MBTA will play in the Greater Boston of the future."[34] Massport actively participated in the Focus40 planning process to provide input on the role of Logan Airport and other Massport assets.

Massachusetts State Freight Plan

In 2016, MassDOT began the process of preparing a new, comprehensive Massachusetts State Freight Plan to look at the near-term and long-term vision for the freight system in Massachusetts. MassDOT released a final draft plan, which was approved by the Federal Highway Administration in 2017. The new plan will include all freight modes, including air, rail, truck, and maritime. This plan will help document and guide Massport's freight planning work at Logan Airport, the Port of Boston, and Massport's other assets. The plan includes the designation of new miles of Critical Urban and Rural Freight Routes to the National Highway Freight Network, improving connections to Logan Airport and Massport maritime facilities. The State Freight Plan will also assist in identifying cargo trends. For example, the 2010 Massachusetts State Freight Plan[35] found that air freight shipping will grow more quickly than any other shipping mode. Massport was actively engaged in the Statewide Freight Plan public process as a member of the leadership Freight Advisory Committee.

33 Transportation for persons with disabilities to supplement public transportation systems.

34 Massachusetts Department of Transportation. 2018. *Focus40*. https://www.mbtafocus40.com/.

35 Massachusetts Department of Transportation. September 2010. *State Freight Plan*. https://www.mass.gov/service-details/freight-plan.

Massachusetts State Rail Plan[36]

In 2010, MassDOT developed the first State Rail Plan to guide planning and investment in freight, commuter, and passenger rail services across Massachusetts. The current plan, which was issued in 2018, lays out a 20-year vision and a four-year action plan describing policies, planning, infrastructure, and investment to guide the state's rail system. Massport advised and supported MassDOT on this plan.

Regional Cooperative Planning Efforts

Massport participates in regional transportation planning efforts, which are listed below.

New England Regional Airport System Plan (NERASP)[37] – Commercial Service Airports

In fall of 2006, the FAA New England Region, in concert with the New England Airport Directors and New England State Aviation Directors, completed the NERASP.[38] The results of this study describe the foundation of a regional strategy for the air carrier airport system to support the needs of air passengers through 2020. To date, the development of that strategy has been instrumental in facilitating the investment and development of the primary commercial airport system in New England.

New England Regional Airport System Planning – General Aviation (NERASP-GA)

While preparing the 2006 NERASP study, the group recognized that a similar evaluation of GA would provide a greater understanding of infrastructure investment, as well as a common understanding of state airport systems in relation to the New England region as a whole. New England and state aviation officials, in partnership with the FAA, conducted a study of the GA airport system in New England, which includes primary commercial service airports that provide a GA service component. Assisted by this information, the FAA will be better positioned to make decisions regarding priority capital investments in the context of rising airport and aircraft operational costs, declining operational activity, aging infrastructure, and limited state funds to address improvements. The 2015 study, *The Evolving Role of our General Aviation Airports and Their Significance to New England* can be found at https://www1.maine.gov/mdot/aviation/docs/neraspgasummarybrochure.pd.pdf.[39]

Local Planning Efforts

At a local level, Massport engages with municipalities, particularly the City of Boston, to coordinate on transportation planning and land use issues. Three recent plans, released by the City of Boston and discussed below, provide a relevant policy framework.

36 Massachusetts Department of Transportation. 2018. *State Rail Plan*. https://www.mass.gov/service-details/rail-plan.
37 Information on the NERASP-GA study can be found at https://www.faa.gov/airports/new_england/planning_capacity/airport_system_plan/.
38 The *New England Regional Airport System Plan* (NERASP), which was published by the FAA in 2006, includes Logan International Airport and these 10 regional airports: Bangor International, Bradley International, Burlington International, Hanscom Field, Manchester-Boston Regional, Portland International, Portsmouth International, T.F. Green, Tweed-New Haven, and Worcester Regional airports.
39 The Evolving Role of our General Aviation Airports and Their Significance to New England - A Profile of the New England General Aviation Airports: Phase 1 Summary of Findings, September 2015, prepared for New England State Aviation Directors by Louis Berger, Airports Solutions Group, and ICF International.

Imagine Boston 2030

Imagine Boston 2030, the City of Boston's comprehensive plan, commenced in the fall of 2015 and was published in July 2017. This latest citywide plan provides a policy framework for future development in Boston, addressing key themes including: housing, mobility, climate adaptation, open space, equity, arts and culture, design and placemaking, and health. Many themes addressed in this plan will inform Massport's planning efforts. At the same time, Massport continues to engage with the City of Boston and other stakeholders to shape the implementation of relevant strategies.

GoBoston 2030

The City of Boston's long-range transportation plan, GoBoston 2030, is intended as both a visioning and action plan to guide transportation planning policy and infrastructure investments through 2030. The plan, released in 2017, expresses three guiding principles: equity, economic opportunity, and climate responsiveness, as well as primary goals and aspirational targets. These targets include expanding access to transportation options, improving safety, reducing commute times, and promoting mode shift. To meet these aspirational targets, the plan prioritizes capital investments in transportation improvements. Many of these transportation planning initiatives will impact Massport's facilities and include projects for which Massport is a key stakeholder.

Climate Ready Boston

Climate Ready Boston is an ongoing initiative to guide Boston toward a more affordable, equitable, connected, and resilient future. Components of the Climate Ready Boston plan include: updating climate projections (e.g., extreme temperatures, sea level rise, and precipitation); completing vulnerability assessments; identifying impacts to focus areas; and creating more climate resiliency initiatives through policy, planning, and financial initiatives. Climate Ready Boston is coordinated with Imagine Boston 2030 and Go Boston 2030. In December 2016, the study report was released and followed by neighborhood implementation strategies in 2017 and 2018.

Conference of New England Governors (CONEG) and the Conference of New England Governors and Eastern Canadian Premiers (NEG/ECP)

The CONEG is a formally established body that coordinates regional policy programs in the areas of economic development, transportation, environment, energy, and health, among others. The CONEG also provides secretarial support to the separate Conference of New England Governors and Eastern Canadian Premiers (NEG/ECP). The latter coordinates policies of common interest across borders including infrastructure, energy, the environment, economic development, and trade. The CONEG offers a forum for policy on aviation and intercity passenger rail, particularly in the northeastern coastal mega-region, as part of a larger transportation system that needs modal balance. Efficient use of this multi-state network affects the overall viability of the highway, aviation, freight, and commuter rail transportation networks that serve the region and the nation. Improved planning coordination between airports and intercity passenger rail services and related ground transportation offers the potential to achieve complementary investments in airport and rail capacity and services.

MassDOT has a representative on the NEG/ECP Transportation and Air Quality Committee, which covers regional transportation issues and infrastructure development, use, and efficiency. The NEG/ECP and other

policy decision makers throughout the region have been able to utilize strategies and information developed in the NERASP, which provides a framework for integrated regional aviation policy and planning. This organization helps to achieve a greater balance between air, rail, and auto trips, and ultimately increase overall transportation capacity without overburdening Logan Airport and the New England aviation system.

In 2015, the NEG/ECP passed and implemented the *Climate Change Action Plan,* which provided direction on reducing greenhouse gas emissions and a target range of at least 35 to 45 percent below 1990 levels by 2030.[40] Since 1973, the six New England states and the five Eastern Canadian provinces have worked cooperatively to address their shared interests across the border. Through the annual conferences of governors and premiers and discussions of joint committees, NEG/ECP encourages cooperation by:

- Implementing adaption strategies;
- Building resilience into infrastructure;
- Developing networks and relationships;
- Taking collective action;
- Engaging in regional projects;
- Undertaking research; and
- Increasing public awareness of shared interests.

Among the topics recently addressed by the governors and premiers are:

- Ensuring a clean, efficient, and reliable energy future for the region;
- Invoking energy innovation for a competitive economy via energy diversification and storage;
- Changing global energy markets and the region’s energy landscape;
- Encouraging business-to-business programming;
- Cross-border partnerships for economic development and trade liberalization;
- Transportation and air quality;
- Climate change action plans and greenhouse gas emission reduction strategies;
- Energy-efficient vehicle and infrastructure technologies; and
- Cross-border mutual aid in emergency planning.[41]

40 Conference of New England Governors and Eastern Canadian Premiers. August 30, 2015. *Resolution 39-1, Resolution Concerning Climate Change*.

41 Coalition of Northeastern Governors. 2019. *New England Governors/Eastern Canadian Premiers*. http://www.coneg.org/negecp.

Regional Rail Transportation Initiatives

This section reports on recent developments and current rail service originating in Boston, the status of air-rail linkages in the NEC, and the expanding Pilgrim Partnership, which provides commuter rail between Massachusetts and Rhode Island.

Amtrak Northeast Corridor (NEC)

Amtrak's NEC is an intercity rail line that operates between Boston-South Station and Washington, DC via New York City. Other major destinations served by the route include Providence, Rhode Island; New Haven, Connecticut; Philadelphia, Pennsylvania; and Baltimore, Maryland. Logan Airport passengers can connect directly to Boston-South Station via Silver Line bus rapid transit (BRT) service or via taxi or other unscheduled mode. Amtrak operates two services between Boston and Washington, DC: the Acela Express (high-speed, limited-stop service) and the Northeast Regional (lower-speed service that makes local stops along the route). Travel times on the Acela Express range from approximately 3.5 hours from Boston to New York to approximately 6.75 hours from Boston to Washington, DC. Travel times on the Northeast Regional range from about 4.25 hours from Boston to New York to approximately 7.75 hours from Boston to Washington, DC. On weekdays, a total of 19 daily departures are offered from Boston-South Station to New York-Penn Station, of which about half are Acela Express. On Saturdays and Sundays, a total of 12 departures and 15 departures are offered from Boston-South Station to New York, respectively.[42] Most trips continue south to Washington, DC, and a smaller number of Northeast Regional trains continue further south to Central and Eastern Virginia.

System-wide Amtrak ridership was 31.7 million trips in FY 2018.[43] During that same time period, the NEC carried 12.1 million passengers on its Acela Express and Northeast Regional services, up about 1 percent from the prior year. Acela Express accounted for more than 3.4 million passengers, while the Northeast Regional accounted for 8.6 million passengers. Overall NEC ridership reached a new record in 2017, surpassing 2016 record levels. Amtrak's share of the Northeast total passenger market has increased substantially since the introduction of Acela Express service in 2000. This share may rise as Amtrak introduces its new rail cars into service in 2019, replacing the old "Amfleet I" cars on the NEC with contemporary rail equipment. Amtrak will also introduce next-generation Acela rail cars (scheduled to enter service in 2021), which will increase the number of seats per train by 27 percent.[44]

42 Amtrak. 2019. Train Schedules and Timetables. https://www.amtrak.com/train-schedules-timetables.

43 Amtrak. September 2018. *Amtrak Facts*. https://www.amtrak.com/national-facts.

44 Ted Mann for The Wall Street Journal. May 12, 2019. "Next-Generation Acela Rail Cars Taking Shake in N.Y. Factory." https://www.wsj.com/articles/next-generation-acela-rail-cars-taking-shape-in-n-y-factory-11557662401.

Northeast Corridor Capital Investment Program and Next-Generation High Speed Rail Plan

The *Northeast Corridor Infrastructure Master Plan*, a regional rail planning study, was released in May 2010. The Master Plan[45] documents NEC growth needs through 2030, including expanded capacity and improvements in Boston-New York and New York-Washington intercity travel times. Forecasted growth and corresponding investment needs over the 20-year study period include: a 76-percent increase in rail ridership from 13 million to 23 million,[46] a 36-percent increase in train movements from 154 average weekday to 210 average weekday, and $52 billion in additional capital investment.

To follow up on the release of the *Northeast Corridor Infrastructure Master Plan*, Amtrak also unveiled a next-generation high-speed rail proposal in September 2010, titled *A Vision for High-Speed Rail in the Northeast Corridor*. The proposal outlines a brand-new 427-mile two-track corridor running from Boston to Washington, DC, offering high-speed rail service with sustained maximum speeds of 220 mph. Operations simulations estimate 83-minute trip times between Boston and New York by 2040 and 3-hour and 23-minute trip times between Boston and Washington, DC. Under this Next-Generation high-speed rail plan, the New York City – Boston market would see a further shift in demand from auto and air to rail due to the dramatic improvements in rail travel times, and the air market between the two city-pairs is projected to be nearly eliminated by 2050.[47] This plan states that traveler's shift to high-speed rail would reduce delays on competing modes (air and auto) and the shift away from shorter and smaller intraregional flights would free up air transport capacity for higher-value transnational and international flights.[48]

An update to the *Northeast Corridor Infrastructure Master Plan* and *A Vision for High-Speed Rail in the Northeast Corridor* was released in July 2012. Since these two documents were released, the two programs have been integrated into a single coherent service and investment program, called the Northeast Corridor Capital Investment Program. The Northeast Corridor Capital Investment Program would advance the near-term projects outlined in the Master Plan to benefit the NEC, while incrementally phasing improvements to the Acela Express high-speed service to support the proposed next-generation high-speed rail.[49] The near-term NEC improvements, which include new equipment for high-speed trainsets, are identified to occur between 2012 and 2025, and the long-term Next-Generation High-Speed Rail improvements are identified to occur between 2025 and 2040. The publication of the 2012 update is the first step in "improving the NEC for all users in order to sustainably support the population and economic growth facing the Northeast over the next 30 years," but a considerable amount of additional planning work is required by all stakeholders.[50] The Federal Railroad Administration (FRA) prepared a comprehensive plan for the NEC, entitled NEC FUTURE. The FRA has worked closely with NEC states, railroads, stakeholders, and the public to define a long-term vision for the corridor's future. In July 2017, the FRA issued the Record of Decision for NEC FUTURE, which describes the

---

45 The NEC Master Plan Working Group. 2017. *The Northeast Corridor Infrastructure Master Plan*. https://nec.amtrak.com/resource/northeast-corridor-infrastructure-master-plan/northeast-corridor-infrastructure-master-plan/.

46 Includes ridership on Amtrak and state rail lines but excludes ridership on commuter rail lines.

47 Amtrak. September 2010. *A Vision for High-Speed Rail in the Northeast Corridor*. http://www.america2050.org/upload/2011/04/Amtrak_NECHSRReport92810RLR.pdf.

48 *Ibid.*

49 Amtrak. July 2012. *The Amtrak Vision for the Northeast Corridor: 2012 Update Report*. http://www.gcpvd.org/wp-content/uploads/2012/07/Amtrak_Amtrak-Vision-for-the-Northeast-Corridor.pdf.

50 *Ibid.*

vision.[51] The FRA will work with the NEC Commission, as well as states and railroads, on service development planning in support of this vision.

In 2015, the Rhode Island Department of Transportation (RIDOT) and Amtrak began work on the Kingston Station Capacity Expansion. The project will improve train operations and the passenger experience along the Rhode Island stretch of the Northeast Corridor. The project features the construction of a third track at Kingston Station, which will enable higher speed Acela trains to safely bypass regional trains. The project was completed in 2017.[52]

RIDOT is also planning improvements to Providence Station, including interior and exterior station enhancements. This project will analyze improvements that may provide new capacity for high-speed services.[53]

Northern New England Intercity Rail Initiative

Completed in 2016, the Northern New England Intercity Rail Initiative is an interstate, interagency collaboration between MassDOT, the Vermont Agency of Transportation, and ConnDOT "to examine the benefits, opportunities, and impacts of more frequent and higher speed intercity passenger rail service on two major rail corridors."[54] The studied corridors are the Inland Route (between South Station and Western Massachusetts via Worcester and Springfield) and the Boston to Montreal Route. The study will evaluate ridership, environmental impacts, and service plans of the 470 miles along these two corridors.

Boston-South Station Expansion

In support of the Northeast Corridor Capital Investment Program, MassDOT is planning to expand Boston's South Station Rail Terminal capacity and related layover capacity to meet current and anticipated future (2035) high-speed, intercity, and commuter rail services needs on the NEC and on the MBTA's South Side commuter rail system. At present, South Station operates above its design capacity for efficient train operations and orderly passenger queuing. Operating with only 13 tracks, South Station constrains the current and future rail mobility within Massachusetts and throughout New England and the NEC.[55] The proposed South Station Expansion Project will result in a number of benefits to rail mobility, including:[56]

- Growth in passenger rail transportation along the NEC and within Massachusetts;
- Improved service reliability through updates to rail infrastructure and related layover capacity;
- Improved passenger capacity and experience of using South Station;
- City-building in a key area of Boston; and
- Reopening of Dorchester Avenue for public use and enjoyment for the first time in decades.

51 Available online at: https://www.fra.dot.gov/necfuture/project_docs/reports.aspx.
52 Amtrak. *Kingston Station Capacity Expansion.* https://nec.amtrak.com/content/kingston-station-capacity-expansion.
53 Amtrak. *Providence Station Improvements.* https://nec.amtrak.com/content/providence-station-improvements.
54 Massachusetts Department of Transportation. Northern New England Intercity Rail Initiative. http://www.massdot.state.ma.us/northernnewenglandrail/Home.aspx.
55 Massachusetts Department of Transportation. *About this Project.* http://www.massdot.state.ma.us/southstationexpansion/Home.aspx.
56 Massachusetts Department of Transportation. October 2017. *South Station Expansion Final Environmental Assessment and Section 4(f) Determination.* https://www.massdot.state.ma.us/southstationexpansion/Documents/FinalEnvironmentalAssessment.aspx.

The Massachusetts Environmental Policy Act (MEPA) environmental review process for this project concluded with the issuance of a Secretary's Certificate on August 12, 2016 on the Final Environmental Impact Report (FEIR).[57] The National Environmental Policy Act (NEPA) environmental review process for this project concluded with the issuance of a Final EA and Section 4(f) Determination and Finding of No Significant Impact (FONSI) on October 27, 2017.[58] Prior to issuance of the final EA, FRA and MassDOT had collected comments on the Draft EA and Draft Section 4(f) Determination for a 30-day public comment period, which concluded May 27, 2017. The draft document was circulated to agencies, project stakeholders, and individuals on the project distribution list for review and comment. Written responses to comments were provided in the FONSI.

North-South Rail Link

Boston is served by two commuter rail systems, one extending to the north of the city, the other to the south. They are disconnected from each other, limiting north to south connectivity for the MBTA commuter rail system as well as Amtrak's intercity rail system. The North-South Rail Link is a proposed pair of rail tunnels that would connect North and South Stations in downtown Boston. MassDOT completed a Draft Environmental Impact Report (DEIR) between 1995 and 2003, but the project was not pursued at that time. MassDOT recently completed a Feasibility Reassessment for the North-South Rail Link Project to update the prior work and inform MassDOT's and state policy makers' decisions about appropriate next steps for the proposed project. The North-South Rail Link Feasibility Reassessment Draft Report was released in September 2018.[59]

East West Rail Study

MassDOT is conducting a study to examine the costs, benefits, and investments necessary to implement passenger rail service from Boston to Springfield and Pittsfield, with the speed, frequency, and reliability necessary to be a competitive option for travel along this corridor. The study will assess up to six alternatives, which will feature a range of approaches including high speed rail and potential infill stations.[60]

Commuter Rail Services

The Pilgrim Partnership is an arrangement between the MBTA and RIDOT, under which RIDOT allocates some of its federal funding to the MBTA in return for commuter rail service between Boston and Rhode Island, and new equipment purchases and improvements to facilities in Massachusetts. The Pilgrim Partnership provides residents in the greater Boston area with improved access to jobs located in Providence. On weekdays, 20 round trips are provided between Boston and Providence. On Saturdays, nine round trips are provided between Boston and Providence, while seven round trips are provided on Sundays.[61] Expanded weekday commuter rail service to T.F. Green Airport in Warwick, Rhode Island was introduced in December 2010, which provides more options for inter-city travel for Boston residents and costs passengers $8.25 each way. Travel time between Boston and Warwick is approximately 1.3 to 1.7 hours. On weekdays, eight of the 20 daily outbound trips from

57 Massachusetts Department of Transportation. June 2016. *South Station Expansion Final Environmental Impact Report.* http://www.massdot.state.ma.us/southstationexpansion/Documents/FEIR.aspx.

58 Massachusetts Department of Transportation. October 2017. *South Station Expansion Final Environmental Assessment and Section 4(f) Determination and Finding of No Significant Impact.* https://www.massdot.state.ma.us/southstationexpansion/Documents/FinalEnvironmentalAssessment.aspx.

59 Available online at: https://www.mass.gov/lists/north-south-rail-link-feasibility-reassessment-study-documents.

60 Available online at https://www.mass.gov/east-west-passenger-rail-study

61 Massachusetts Bay Transportation Authority. 2019. Providence/Stoughton Timetable. https://www.mbta.com/schedules/CR-Providence/timetable.

Boston to Providence currently continue to Warwick as well as Wickford, Rhode Island. Expanded weekday service to Wickford, Rhode Island commenced in 2012, with a potential extension further into South County as service in the state expands and ridership grows. Additionally, RIDOT, in cooperation with the City of Pawtucket, is currently investing $40 million in the construction of a new commuter rail station in Pawtucket, Rhode Island, which will serve MBTA commuter trains. The new Pawtucket-Central Falls Commuter Rail Station is scheduled to open in 2022.

The expansion of commuter rail service into Rhode Island enhances ground access options from the Boston metropolitan area to T.F. Green Airport. The passenger catchment areas of T.F. Green Airport and Logan Airport overlap, and this commuter rail service has the potential to attract passengers in the overlapping catchment area who live along the MBTA's Providence Line to T.F. Green Airport.

Massachusetts officials cleared funding hurdles in April 2019 to begin expansion of MBTA commuter rail service to major cities like New Bedford and Fall River (located within approximately 50 miles of Boston and without regular commuter rail service to the capital) via the South Coast Rail corridor. This two-phase, $3.42-billion construction will extend the existing Middleborough Line from Boston and bring six new stations and two new layover facilities, with a target date for operational service for Phase 1 ($1.05 billion) by late 2022.[62] The first phase includes reconstruction of existing tracks and upgrades to the Middleborough secondary track. The second phase of the project will provide service to the South Coast through the Town of Stoughton. Some service will begin in 2023, but several portions of the project are not expected to reach completion until 2030.

MBTA Rail Vision

The MBTA's Rail Vision planning study will identify cost-effective strategies to transform the MBTA's existing Commuter Rail system to better support improved mobility and economic competitiveness in the Boston region. The study will evaluate how best to serve riders and determine which investments support the final vision. The project includes:

- Coordination with other initiatives on factors that may affect transportation and the market for MBTA commuter rail service (such as the distribution of population growth, or the impact of autonomous vehicles);
- Development of objectives that a future MBTA rail system should support;
- Identification of up to eight alternatives that range from those that require less capital-intensive operational strategies to those that require major infrastructure upgrades and new technologies;
- Evaluation of the alternatives using a variety of tools—including operations simulations and models of ridership and land use; and
- Engagement with stakeholders to ensure that the recommended vision has been developed based on a variety of ideas and opinions.

62 Chris Lisinski, State House News Service, for WBUR. 2019. "Permit, Funding Hurdles Cleared for South Coast Rail." https://www.wbur.org/bostonomix/2019/04/23/south-coast-commuter-rail-permit-funding.

A thorough evaluation of the costs, ridership potential, and operational feasibility of these alternatives, as well as a broad public conversation in 2019, will inform the ultimate vision for the future of the MBTA rail system.[63]

Other Regional Cooperative Planning Efforts

Recognizing that Logan Airport is a substantial trip generator and key transportation resource in the metropolitan area, Massport participates in several interagency transportation planning forums that strive to enhance a variety of travel modes.

South Boston Waterfront Transportation Plan

Massport, the City of Boston, MassDOT, and the Massachusetts Convention Center Authority all participate in and manage the new sustainable transportation plan for the South Boston Waterfront. The resulting plan, featuring an unprecedented collaboration of the private and public sectors, is a blueprint for improving the growth of the Waterfront, proposing solutions to meet the growing and changing transportation needs of the district, and improving the public realm of the area, all while preserving the quality of life for the surrounding neighborhoods. The plan benefitted from the input of area stakeholders through five community meetings and more than 50 outreach meetings throughout the process. Massport continues to engage in implementation of recommendations from this plan, in collaboration with other agency partners.

The City of Boston published the *Coastal Resilience Solutions for South Boston* report in October 2018. This plan presents near-term and long-term visions for reducing risk due to sea level rise and coastal flooding in South Boston. This is the second neighborhood coastal resilience plan to come out of the Climate Ready Boston initiative.

Water Transportation Advisory Council and Ferry Study

Massport participates in planning for water transportation in the Boston region as a member of state Water Transportation Advisory Council, convened by MassDOT. Massport also participated in a comprehensive study of commuter, recreational, and landside access needs to support water transportation in Boston Harbor, which was completed in April 2019. The study identified three potential corridors for water transportation service and developed business plans to assess ridership and implementation feasibility. Massport served on the steering committee for this study led by Boston Harbor Now with support from MassDOT and other stakeholders.

Boston Metropolitan Planning Organization (Boston MPO)

Massport supports multimodal transportation planning and improved integration of its facilities with Boston area transportation through its permanent voting membership on the Boston MPO and by providing input on the Boston MPO's policy and programming decisions.

MPOs are established in large metropolitan areas and are responsible for conducting a federally required cooperative, comprehensive, and continuous metropolitan transportation planning processes. Based on this planning, MPOs determine which surface transportation system improvements will receive federal capital (and occasionally, operating) transportation funds. The Boston MPO´s mission is to establish a vision and goals for transportation in the region and then develop, evaluate, and implement strategies for achieving them.

63 Massachusetts Bay Transportation Authority. *Rail Vision.* https://www.mbta.com/projects/rail-vision.

Massport plays an active role on the MPO's decision making board, participating in policy decisions related to the *Long-Range Regional Transportation Plan,* and project programming for the Transportation Improvement Program. The MPO also guides the work conducted by Central Transportation Planning Staff (CTPS) via its Unified Planning Work Program. CTPS also supports Massport's ground transportation planning initiatives.

Metropolitan Area Planning Council (MAPC)

Massport is also an ex-officio member of the Executive Committee of MAPC, a regional planning agency that serves the people who live and work in the cities and towns of Metropolitan Boston. The MAPC mission is to promote smart growth and regional collaboration, which includes protecting the environment, supporting economic development, encouraging sustainable land use, improving transportation, ensuring public safety, advancing equity and opportunity among people of all backgrounds, and fostering collaboration among municipalities. MAPC membership includes 101 municipal government representatives, 21 gubernatorial appointees, 10 state officials (including Massport), and three City of Boston officials. A staff of approximately 40 individuals supports the Council and its Executive Committee of 25 selected members.

This Page Intentionally Left Blank.

5

Ground Access to and from Logan Airport

Key Findings
▪ Boston Logan International Airport (Logan Airport or the Airport) continues to be one of the top of U.S. airports in terms of high-occupancy vehicle (HOV) and transit mode share. The Massachusetts Port Authority (Massport) promotes numerous HOV, transit, and shared-ride options to improve on Airport roadway and curbside operations, alleviate constraints on parking, and improve customer service. Key initiatives include: ▪ A goal to double Logan Express ridership by expanding parking, frequency, and facility upgrades; ▪ A plan to purchase eight additional Massachusetts Bay Transportation Authority (MBTA) Silver Line buses, increasing the fleet size purchased by Massport to 16 buses; and ▪ Implementation of a transportation network company (TNC, such as Uber and Lyft) management plan to reduce congestion on-Airport, including a focus on ride rematch[1] and shared-ride.
▪ Average weekday on-Airport vehicle miles traveled (VMT) increased by about 11 percent from approximately 176,840 in 2016 to 196,500 in 2017. The change in average daily traffic can be attributed primarily to the increases in air passenger activity, passenger drop-off/pick-up, cargo, and non-aviation related Airport uses.
▪ In 2017, Massport began tracking and reporting TNC activity. TNCs were estimated to contribute about 15,000 vehicle trips per day (excluding deadhead trips[2]). TNCs are impacting other access modes to the Airport and contributing to on-Airport congestion.
▪ Partially due to the emergence of TNCs, black car limousines and scheduled van ridership dropped by 40 percent from 2016 to 2017. Taxi dispatches declined 18 percent and MBTA Blue Line ridership decreased by 2 percent in 2017 compared to 2016.
▪ In 2017, the Logan Airport Parking Freeze was amended to allow for an increase of up to 5,000 on-Airport commercial parking spaces, which allows for the construction of additional parking to reduce drop-off/pick up modes and alleviate constrained on-Airport parking conditions.
▪ Based on ongoing changes in passenger mode choice for accessing Logan Airport, Massport has updated its goals and definition of HOV. The updated definition considers vehicle occupancies of taxis, black car limousines, and TNCs that exceed one air passenger per vehicle to be HOV, while the same modes with one air passenger will count as non-HOV. With this updated definition, Massport has committed to a goal of 35.5 percent HOV by 2022 and 40 percent by 2027.
▪ When activity levels reach 50 million air passengers, it is anticipated that Massport transportation policy changes and potential infrastructure modifications that reduce on-Airport VMT will be in place. Infrastructure modifications may include on-Airport dedicated HOV bus lanes, the creation of an intermodal transportation center with bus service to terminals, the possible construction of an Automated People Mover (APM), or some combination of these improvements.

1 Rematch allows drivers who are dropping off to instantly pick up another passenger without needing to circle the Airport or leave empty.

2 Deadhead trips are those trips to or from the Airport that do not contain a passenger.

Introduction

Massport has a comprehensive, multi-pronged, trip reduction strategy to diversify and enhance ground transportation options for passengers and employees traveling to and from Logan Airport. The ground transportation strategy is designed to offer passengers traveling to and from Logan Airport with a choice of HOV, transit, and shared-ride options that are convenient and reliable, and that reduce environmental and community impacts.

The strategy also aims to provide sufficient on-Airport parking for air passengers choosing automobile access modes and/or who have limited HOV options. Improving the multimodal connectivity of the Airport can provide traffic and environmental benefits by reducing vehicle trips, VMT, and greenhouse gas (GHG) emissions associated with travel to and from Logan Airport. The cost, speed, convenience, safety, and reliability of all modes of transportation connecting to the Airport affect how passengers and employees choose among these access modes. Offering a range of ground access options also improves customer service for air passengers, employees, and other Airport users.

Along with reducing congestion and limiting impacts to the environment:

- Massport continues to invest in and operate Logan Airport with a goal of increasing the HOV mode share—the number of passengers (and Airport employees) arriving by transit or other HOV and shared-ride modes. Measures implemented by Massport to increase HOV use include initiatives related to pricing (incentives and disincentives), service availability, service quality, infrastructure improvements, marketing, and traveler information.
- Massport aims to reduce the number of private vehicles that access Logan Airport and, in particular, reduce the associated environmentally undesirable drop-off/pick-up modes, which generate up to four vehicle trips instead of two.[3]
- Massport actively manages parking supply as another strategy to reduce drop-off/pick-up modes by promoting long-term rather than short-term parking (thus reducing the number of daily trips to Logan Airport); supporting efficient use of parking facilities; providing good customer service; and complying with the provisions of the Logan Airport Parking Freeze.[4]

In addition to highlighting more recent changes to ground transportation services, operations, and pricing, this chapter reports on ground access conditions and activity levels in 2017, which are compared to past conditions. Activity levels include measures of ridership on various ground access modes and traffic volumes. The chapter provides an overview of parking demand and its impacts under Logan Airport's constrained parking supply. Regional transportation efforts related to the Airport, as well as planning efforts to diversify

3 If an air passenger is dropped off when departing on an air trip and is picked up upon return, that single air passenger generates a total of four ground access trips: two for the drop-off trip (one inbound to Logan Airport, one outbound from Logan Airport) and two for the pick-up trip (one inbound to Logan Airport, one outbound from Logan Airport). The air passenger may be dropped off and picked up in a private vehicle, taxi, TNCs, or a black car limousine and the vehicle may not carry a passenger during all segments of travel to and from Logan Airport.

4 310 Code of Massachusetts Regulations 7.30; 40 Code of Federal Regulations 52.1120.

transportation options in the New England region (primarily through high-speed, commuter, and passenger rail), are discussed in Chapter 4, *Regional Transportation*.

This chapter also reports on future forecast conditions. The predicted value for VMT at Logan Airport is based on projected passenger activity levels for the Future Planning Horizon (the next 10 to 15 years), when Logan Airport is anticipated to reach 50 million annual air passengers. For further information on the development of the Future Planning Horizon forecast, refer to Chapter 2, *Activity Levels*.

Ground Transportation Modes of Access to Logan Airport

The Logan Airport Environmental Data Reports (EDRs) and Environmental Status and Planning Reports (ESPRs) provide over three decades of tracking and reporting on ground access and ground transportation at the Airport. Air passengers have a variety of options for getting to Logan Airport, including:

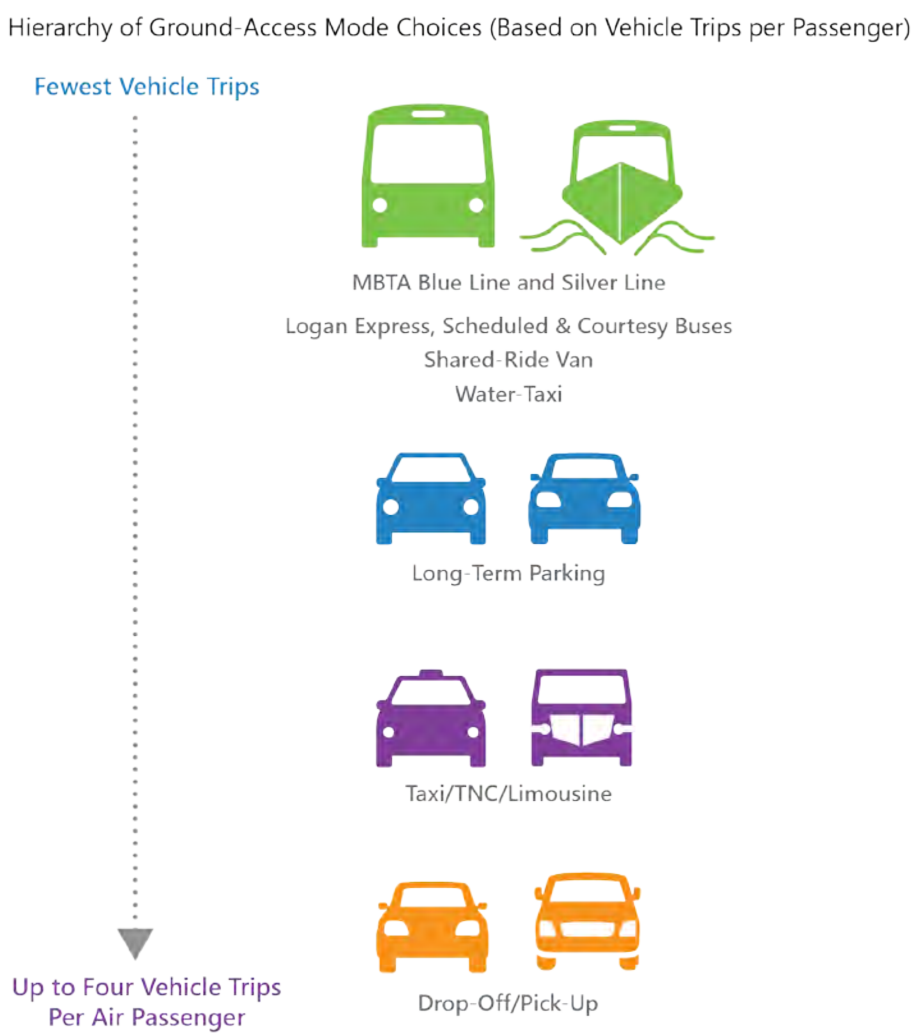
- Public transit (MBTA Blue Line subway, Silver Line bus rapid transit, other MBTA buses, and water transportation);
- Logan Express scheduled bus service;
- Scheduled buses and vans;
- Courtesy shuttle buses;
- Charter buses;
- Private automobiles;
- Unscheduled private black car limousines and vans;
- Taxis;
- Rental cars; and
- TNCs, such as Uber and Lyft.

Mobile application ride-booking services, such as Uber and Lyft, are increasingly becoming a mode of choice for ground access at airports throughout the country. In February 2017 (pursuant to Massachusetts state law, An *Act Regulating Transportation Network Companies* (Bill H.4570), and Massport *Rules for Safe and Efficient Operation of TNCs at Logan Airport* and in cooperation with state regulators), Massport began allowing TNCs to pick up arriving air passengers after entering a dedicated TNC pick-up lot. This service was tracked for reporting beginning in 2017 and contributed an estimated 15,000 vehicle trips per day, excluding deadhead trips (deadhead trips are those trips to or from the Airport that do not contain a passenger). TNC operations at the curb and on roadways is affecting ridership on HOV services and contributing to on-Airport congestion. Massport has a comprehensive plan to address these impacts, as discussed later in this chapter.

Transit, HOV, and shared-ride modes are designed for use by multiple travelers. With a higher occupancy, the number of vehicle trips to and from the Airport per passenger for the transit and shared-ride modes is relatively low, which is beneficial. On the other hand, private vehicles that park at the Airport (or an off-Airport lot) generate a single vehicle trip to the Airport for the departing air passenger and a single vehicle trip from the Airport for the arriving air passenger. Even less desirable, vehicles that do not remain on

the Airport for an air passenger's trip duration, such as those private vehicles that have dropped off an air passenger at the curb, generate a trip to and a trip from the Airport for a departing air passenger and an additional two trips for the arriving passenger. Taxis, TNCs, and black car limousines also produce deadhead trips when they depart Logan Airport empty after dropping off an air passenger (particularly in the morning) or arrive at the Airport empty to pick up air passengers. As **Figure 5-1** shows, when measured in terms of vehicle trips generated, the most environmentally desirable mode is HOV (transit and shared-ride), followed by drive-and-park, with the least desirable modes being drop-off and pick-up**.**

Figure 5-1 Ground Access Mode Choice Hierarchy



Source: VHB.
Notes: Short-term parking is included under "Drop-off/Pick-up."
Rental cars are included in the "Long-Term Parking" category.

2017 On-Airport Vehicle Traffic: Volumes and Vehicle Miles Traveled (VMT)

This section reports on Logan Airport's traffic-related activity for 2017, specifically:

- Gateway traffic volumes; and
- On-Airport VMT calculations.

Massport's leadership in and commitment to developing, promoting, and providing alternative means of ground transportation for access to and from Logan Airport are key to reducing gateway traffic volumes and on-Airport VMT. The diverse range of environmentally responsible transportation modes by which air travelers, employees, and other Airport users can access the Airport reduces reliance on automobile travel, minimizes traffic congestion, and contributes to improvements in air quality.

Gateway Traffic Volumes

Gateway roadways are defined as access points to and from Logan Airport, which primarily include Route 1A to and from the north, the Sumner and Callahan Tunnels (Route 1A to and from the south), the Interstate-90 Ted Williams Tunnel ramps (east/west), and Frankfort Street/Neptune Road. **Figure 5-2** shows the roadway infrastructure at Logan Airport in 2017.

Data Collection and Annual Average Daily Calculation Method

All of the Airport's gateway roadways are equipped with permanent traffic count stations, as part of the Airport-wide Automated Traffic Monitoring System (ATMS). These stations provide data to calculate:

- Annual average daily traffic (AADT);
- Annual average weekday daily traffic (AWDT); and
- Annual average weekend daily traffic (AWEDT).

Since these data are automatically collected continuously throughout the year, seasonal adjustment factors are only necessary when significant gaps in the data occur (typically due to equipment failure/malfunction or construction activity). Seasonal adjustment factors, when used, are generally based on a combination of the seasonality (monthly variation) of counts from other ATMS stations or of the same station in the previous year.

Annual Average Daily Activity Levels

Table 5-1 summarizes the average daily gateway traffic volumes at Logan Airport for the years 2000 and 2010 through 2017. It includes AADT, AWDT, AWEDT, and annual air passengers, for reference.

The AADT entering and departing Logan Airport via its gateway roadways increased by 4.1 percent between 2016 and 2017. The change in average daily traffic can be attributed primarily to:

- A 5.9-percent increase in air passenger activity in 2017 compared to 2016;
- The impact of TNCs, which generated approximately 15,000 vehicle trips per day (excluding deadhead trips); and
- A general increase in drop-off/pick-up activity by private and commercial automobiles.

Although daily traffic volumes on the Airport roadway system have been increasing, it is important to place this growth in the context of overall Airport activity and Massport's efforts to promote HOV ground access. In 2017, air passenger volumes were approximately 40 percent higher than in 2010; while AADT, AWDT, and AWEDT volumes grew at approximately 33 percent over the same time period.

Growth in gateway traffic volumes is also partially attributable to growth in non-air passenger activity such as air cargo, aviation services, and other Airport activities. Even accounting for both non-air passenger and air passenger activity, the fact that gateway traffic volume is growing at a lower rate than air passenger volume reflects the use of HOV modes to access the Airport.

Table 5-1 Logan Airport Gateways: Annual Average Daily Traffic, 2000, 2010–2017

	AADT		AWDT		AWEDT		Annual Air Passengers	
Year	Volume	Percent Change	Volume	Percent Change	Volume	Percent Change	Level of Activity	Percent Change
2000	95,058	3.8%	101,446	3.9%	78,358	2.1%	27,412,926	--
2010	94,179	4.9%	98,968	5.5%	82,595	4.5%	27,428,962	--
2011	99,449	5.6%	104,863	6.0%	85,879	4.0%	28,907,938	5.4%
2012[1]	99,281	(0.2%)	104,439	(0.4%)	86,494	0.7%	29,235,643	1.1%
2013	102,771	3.5%	107,656	3.1%	90,822	5.0%	30,218,970	3.4%
2014	108,172	5.3%	113,564	5.5%	94,881	4.5%	31,634,445	4.7%
2015	113,623	5.0%	119,288	5.0%	99,415	4.8%	33,449,580	5.7%
2016	119,750	5.4%	125,715	5.4%	104,456	5.1%	36,288,042	8.5%
2017	**124,646**	**4.1%**	**130,601**	**3.9%**	**109,723**	**5.0%**	**38,412,419**	**5.9%**

Source: Massport.
Notes: Numbers in parentheses ( ) represent a reduction from the previous year. Gateway roadways include access to/from: Route 1A (including the Sumner and Callahan tunnels), Interstate-90/Ted Williams Tunnel, Frankfort Street/Neptune Road, and Maverick Street.
1 The 2012 air passenger activity level was revised in September 2013.
AADT Annual average daily traffic.
AWDT Annual average weekday daily traffic.
AWEDT Annual average weekend daily traffic.

FIGURE 5-2 Logan Airport Roadway Network

2017 Environmental Status and Planning Report

Parking Garages

Terminal Buildings

Airport Roadways

0 450 900 1800 Feet

On-Airport VMT

On-Airport VMT is calculated based on the total number of miles traveled by all vehicles on the Logan Airport roadway system. VMT is an important metric because it is used to calculate motor vehicle air quality emissions, and it is also one indication of the levels of traffic on roadways in specific areas and at specific times.

Calculation Method and Model Description

In 2011, Massport upgraded its modeling capabilities and began using an on-Airport VISSIM[5] model to estimate VMT. This model can be adapted to reflect changes in the evolving Logan Airport roadway transportation network and is more robust than the previous model developed in 1994, which was based on the prior terminal-area roadway system. The study area of the VISSIM model roadway network can be found in Appendix G, *Ground Access*. The VISSIM model estimates VMT associated not only with curbside activity and parking, but also with Logan Airport employees and facility operations, rental car activity, and hotel activity.

The model is calibrated to existing evening peak hour volume data, which is generally the peak hour of the airport roadway system. Adjustment factors were determined to calculate morning peak hour, highest 8-hour, and average weekday VMT from the VISSIM model. The adjustment factors for the 2017 VMT calculations were determined by using 2015 to 2017 gateway, Airport roadway, and parking volume averages. Tables provided in Appendix G, *Ground Access,* compare existing and simulated traffic volumes at Logan Airport for the 2017 condition.

Estimated VMT Calculations and Modeling Results

Consistent with previous years, the following specific time periods were analyzed for 2017:

- Morning peak hour (5:00 AM to 6:00 AM);
- Evening peak hour (6:00 PM to 7:00 PM);
- Highest consecutive 8-hour (High 8-Hour); and
- Average weekday VMT.

Table 5-2 summarizes the VMT estimates for Logan Airport-related traffic from 2010 through 2017 and provides 2000 data for historical context. Absent any major shift in traffic volumes entering the gateways, the change in VMT is expected to closely mirror the change in traffic volume. However, the change in average weekday VMT between 2016 and 2017 was approximately 11 percent, despite increases in passenger levels of 5.9 percent and traffic volume of 4.1 percent during the same time period. In addition to increased air passenger demand, this increase can be attributed to two primary factors: increased commercial and private drop-off/pick-up activity by passengers and a change in general travel patterns to and from the Airport over the past several years. As noted above, the adjustment factors used to calculate VMT are based on passenger

5 PTV America. 2011. Verkehr In Städen Simulationsmodell – VISSIM version 5.40 [computer software].

and vehicle volumes averaged over several years (2015 to 2017). Previous factors contained average volume data prior to 2015. This was during a time when parking was less constrained, TNCs were not in circulation (or for a portion of time not authorized for pick-up), and the number of passengers was lower. The shift away from these travel patterns was abrupt and may have contributed to an underestimate of VMT for the past one or maybe two years. Details of the 2017 VMT modeling results are presented in Appendix G*, Ground Access*.

Table 5-2 Airport Study Area Vehicle Miles Traveled (VMT) for Airport-Related Traffic, 2000, 2010-2017

Analysis Year[1]	AM Peak Hour	PM Peak Hour	High 8-Hour	Average Weekday	Average Weekday Percent Change
2000	11,213	13,252	85,823	178,798	3.0%
2010	8,451	10,887	78,185	162,885	(4.8%)
2011	8,391	10,978	76,920	167,647	2.9%
2012	8,387	10,974	76,883	167,564	(0.1%)
2013	9,006	11,407	80,088	177,094	5.7%
2014[2]	8,155	10,107	71,361	158,443	(10.5%)
2015	8,580	10,660	76,058	168,791	6.5%
2016	9,009	11,101	79,234	176,841	4.8%
2017	**9,844**	**12,009**	**86,678**	**196,503**	**11.1%**

Source: VHB and Massport.
Notes: Numbers in parentheses ( ) represent a reduction in VMT.
1 Data provided for 2000 and 2010 used the previous VMT model. Data from 2011 to 2017 used the VISSIM model.
2 2014 VMT reflects completion of the Rental Car Center, relocation of the taxi and bus/black car limousine pools, and terminal curbside reallocations in support of the unified shuttle.

2017 Ground Transportation Ridership and Activity Levels

This section of the chapter:

- Provides an overview of transportation services available to Logan Airport users from the Boston metropolitan area;
- Reports on 2017 ridership levels and recent historical trends;
- Reports on Massport's progress in meeting ground access goals; and
- Describes Massport's cooperative planning ventures with other transportation agencies in Massachusetts.

Logan Express, MBTA Transit, and Water Transportation Modes

Annual ridership levels for HOV, transit, and shared-ride transportation modes serving Logan Airport are summarized in **Table 5-3**.

Logan Express Bus Service

Massport provides frequent, scheduled, express coach bus service to Logan Airport for air passengers and Logan Airport employees from suburban park-and-ride lots in Braintree, Framingham, Woburn, and Peabody. Full service bus terminals and secure parking are provided at all four locations. In addition, a pilot urban service from Back Bay was introduced in April 2014. No customer parking is provided at the Back Bay location. **Figure 5-3** depicts Logan Express bus locations with respect to the regional transportation network.

Table 5-3 Annual Ridership and Activity Levels on Logan Express, MBTA, and Water Transportation Services, 2000, 2010–2017

	MBTA Transit		Logan Express Bus			Water Transportation[1]	
Year	**Blue Line[2]**	**Silver Line[3]**	**Air Passengers**	**Employees**	**Total**	**MBTA Ferry**	**Private Water Taxis**
2000	1,518,789	NS	923,236	211,717	1,134,953	82,243	26,335
2010	2,270,241	831,323	644,412	467,020	1,111,432	37,794	54,382
2011	2,277,311	900,359	649,609	536,513	1,186,122	33,403	58,879
2012	2,442,085	906,177	681,040	624,149	1,305,189	30,337	60,840
2013	2,597,306	N/A	733,005	634,693	1,367,698	21,952	70,378
2014[4]	2,378,965	N/A	941,043	632,011	1,573,054	19,340	67,479
2015	2,122,597	N/A	1,150,999	622,005	1,773,004	7,748	70,798
2016	2,240,744	N/A	1,163,201	652,468	1,815,669	7,757	74,788
2017	**2,197,783**	**N/A**	**1,140,235**	**695,504**	**1,835,736**	**7,424**	**83,689**
Percent Change (2016-2017)	**(1.9%)**	**N/A**	**(2.0%)**	**6.6%**	**1.1%**	**(4.3)**	**11.9%**

Source: Massport.
Notes: Numbers in parentheses ( ) represent a decrease in annual ridership.
N/A Not available.
NS Not in service until 2005.
1 MBTA Ferry includes the Harbor Express F2/F2H service, Hingham/Hull-Logan and Long Wharf. Service from Quincy Fore River was suspended in 2013. Private water taxis include: City Water Taxi and Rowes Wharf Transport.
2 Airport Station fare gate entrances facing Logan Airport only. Station activity is not limited to only Airport-related passengers.
3 Boardings at Logan Airport. Silver Line: 2012 values are estimates. No information available for 2013 to present.
4 Back Bay Logan Express pilot program introduced.

Table 5-3 compares 2017 ridership on Logan Express to prior years. Notably, Logan Express passenger ridership from suburban park-and-ride locations increased by over 6 percent from 2016 to 2017 and overall service increased by about 1 percent. There continued to be a decrease in ridership to and from Back Bay, which has been a noted trend since the MBTA's Government Center Station reopened. A detailed breakdown of Logan Express ridership is presented in Appendix G, *Ground Access*.

At suburban locations, Logan Express operates daily between 4:00 AM to 11:00 PM, with some earlier and later bus service provided that varies by location and day of the week. The round-trip adult fare is $22, with reduced fares offered to seniors; children under the age of 17 ride for free. Parking rates at the facility park-and-ride lots are $7 per day. On weekdays and Saturday/Sunday afternoon to evening, scheduled half-hour frequencies are provided between the Braintree and Framingham locations and Logan Airport. One-hour frequencies are provided at these locations on Saturday and Sunday mornings. Woburn provides half-hour bus service on weekdays and Sunday afternoon to evening, and hourly service all day Saturday and on Sunday mornings. Scheduled bus service to and from Peabody is provided hourly.

Given the recent increase of TNC travel modes to and from Logan Airport, Massport has a goal to double Logan Express ridership from 2 million to 4 million passengers, thereby reducing VMT, congestion, and air quality emissions. At suburban locations, Massport proposes the following action plan:

- Increase Braintree Logan Express service from two to three trips per hour (implemented in 2019);
- Add about 1,000 additional spaces to the Framingham garage;
- Build up to 3,000 structured parking spaces at the Braintree site that is nearing capacity;
- Provide security line priority status to Logan Express Back Bay riders (implemented in 2019);
- Execute a sustained marketing campaign to support the Logan Express strategy and increase ridership;
- Implement Logan Express electronic ticketing;
- Evaluate new Logan Express suburban locations, with a plan to open at least one new site.
- Explore TNC Last Mile connections;[6]
- Rebrand Logan Express sites as remote terminals; and
- Continue to monitor parking capacity at all Logan Express sites.

The Back Bay Logan Express operates daily trips between the hours of 5:00 AM and 10:00 PM. One-way fares in 2017 were $7.50 per passenger. Riders with a current, valid MBTA pass received reduced $3 fare. Massport has recently implemented a number of improvements to the service with a focus on boosting urban Logan Express ridership and is considering the following additional services for the near future:

- Change pick-up/drop-off location from Copley to Back Bay Station (implemented in 2019);

6 Individuals who fall within the 0.5-mile to 1-mile drive distance of a Logan Express facility are the most likely group to use TNCs to connect between the facility and their home.

- Discount one-way fare from $7.50 to $3.00 (implemented in 2019);
- Provide free service from Logan Airport (implemented in early 2019);
- Pilot priority security line status for riders (implemented in 2019);
- Execute a marketing campaign to support increased ridership (ongoing);
- Implement Logan Express electronic ticketing; and
- Implement a second urban Logan Express service at North Station.

The service enhancements recently implemented at Back Bay have reversed the downtrend in ridership noted at this location for the past few years.

Rapid Transit

Table 5-3, previously shown, compares 2017 ridership on rapid transit to prior years. Almost 15 percent of passengers with trip origins in Boston, Cambridge, Brookline, and Somerville used MBTA public transit to travel to the Airport via the Blue Line or Silver Line. Both services are important for reducing automobile travel to the Airport; as survey results show, over three quarters of users of the Blue Line and Silver Line indicated that their alternative mode of travel to Logan Airport would have been a taxi or TNC, or that they would have been dropped off at the Airport by private vehicle. **Figure 5-4** illustrates the public transportation options to access Logan Airport.

The data indicate that overall ridership on the Blue Line has decreased since 2016. However, as noted in previous reports, fare gate data do not distinguish between Airport related riders and East Boston users, nor do they distinguish between Logan Airport air passengers and employees. Therefore, Airport passenger ridership levels on the Blue Line cannot be directly identified.[7]

On the Silver Line, bus service from Logan Airport is free and has eliminated the need for fareboxes; thus, 2017 figures of passenger boardings are not available. Transfers between the Silver Line and the Red Line at South Station are free. Eliminating fare collection allows all three doors to be used for boarding, thus improving Logan Airport's curb operations and schedule adherence, and reducing idling. With the Silver Line fleet refurbished (which is now complete), it is anticipated that Massport, with support from the MBTA, will again be able to provide ridership data for Silver Line services through an on-board Automated Passenger Counting system.

In 2017, Massport funded mid-life rebuilds of four Silver Line buses (four additional buses were rebuilt in 2018). The mid-life rebuild extends the useful life of each vehicle by approximately eight years. This will allow the MBTA to maintain reliability and quality of operations along the Silver Line today while initiating the procurement process to acquire new vehicles in the future. Eight Silver Line buses were purchased in 2005 by Massport and are operated by the MBTA, with Massport paying operating costs. Massport plans to purchase an additional eight buses, bringing its total to 16 buses, to increase frequency.

7 Based on automated fare gate entrance counts, approximately 50 percent of entrances occur via the Bremen Street Park fare gates at Airport Station. Based on Massport curbside observations, approximately 45 percent of Airport Station entrances are attributable to Airport users.

FIGURE 5-3 **Logan Express Bus Service Locations, Routes, and 2017 Ridership**

2017 Environmental Status and Planning Report

Logan Airport	**Logan Express Stations**	**Logan Express Routes**	MBTA Station
Main Roads	Back Bay	Back Bay	Blue Line
Massachusetts Municipalities	Braintree	Braintree	Green Line
	Framingham	Framingham	Orange Line
	Peabody	Peabody	Red Line
	Woburn	Woburn	Silver Line

0 10000 20000 40000 Feet

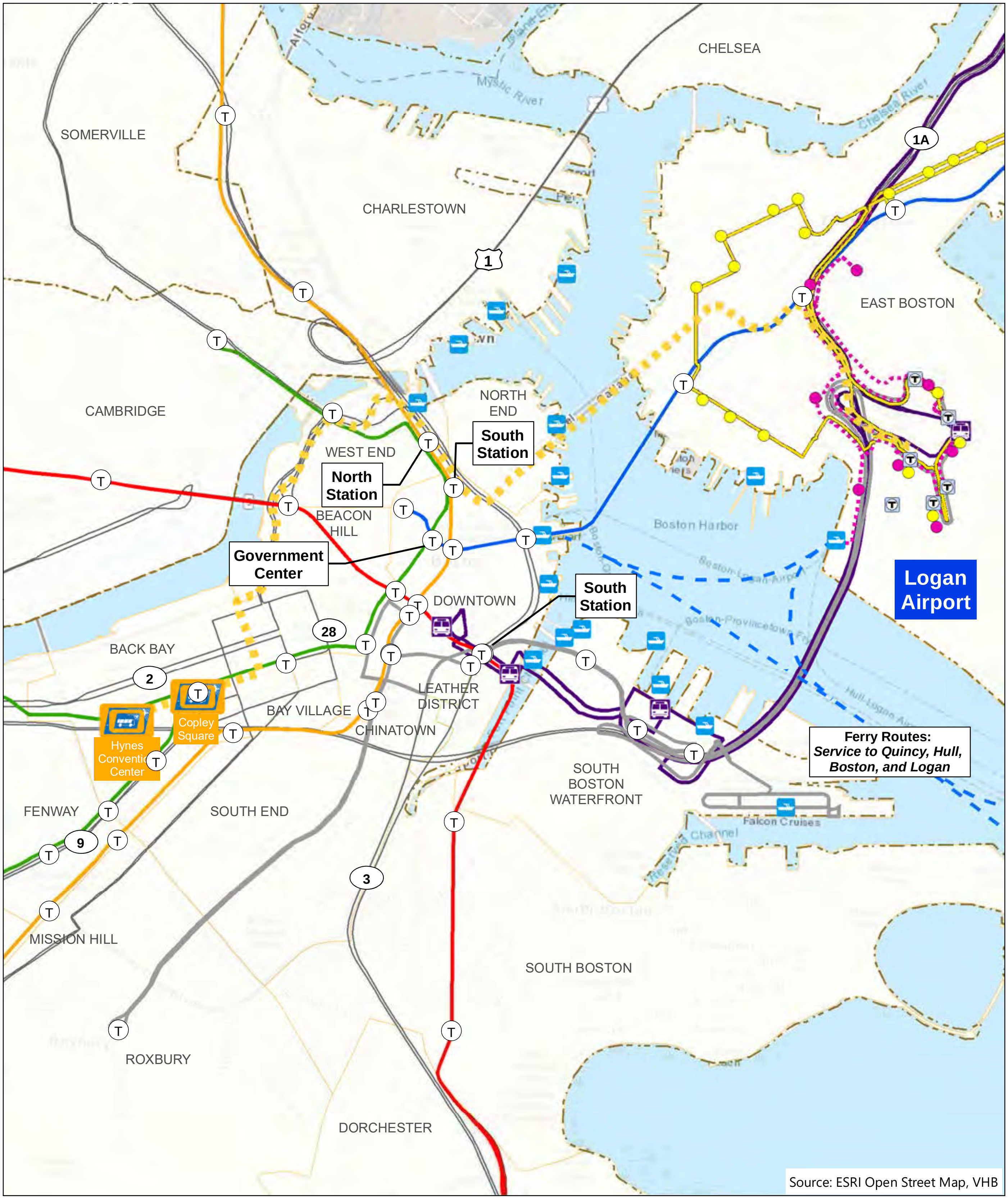


FIGURE 5-4 Public Transportation Options

2017 Environmental Status and Planning Report

- Water Taxi
- Silver Line Stop at Airport Terminals
- MBTA Station
- Back Bay Logan Express Pick Up Locations
- Sunrise Shuttle Routes with Stops
- Airport Shuttle Routes with Stops
- Ferry Route
- Blue Line
- Green Line
- Orange Line
- Red Line
- Silver Line
- MBTA 448, 449, 459 Bus Routes with Stops *Limited service see MBTA website*

0 1500 3000 6000 Feet

Water Transportation

Table 5-3 above compares 2017 ridership on water transportation to prior years. Three companies provide water transportation within the Boston area: Boston Harbor Cruises Water Taxi, Rowes Wharf Water Taxi, and MBTA Harbor Express. Collectively, these companies serve numerous destinations throughout the Boston Inner Harbor. The water taxi landing locations include: Long, Rowes, and Central wharfs; the World Trade Center and the Moakley Courthouse in South Boston; and stops in the North End, Charlestown, Chelsea, and East Boston. A new stop opened in 2019 at Lovejoy Wharf near North Station. The MBTA Harbor Express provides services to Long Wharf and destinations outside of the Inner Harbor, including Hingham and Hull.[8] The water transportation services stop at the Logan Airport dock on Harborside Drive. Massport provides a courtesy shuttle bus service between the Logan Airport dock, the MBTA Airport Station, and all Airport terminals. Massport also provides its employees with a subsidy for water transportation modes. In 2017, the one-way fare to Logan Airport was $9.25 from Long Wharf and $18.50 from Hingham/Hull.[9]

Other HOV Modes: Scheduled Buses, Shared-Ride Vans, Courtesy Vehicles, and Black Car Limousines

Massport provides priority, designated curb areas at all Airport terminals to support the use of HOV and transit modes, including privately-operated scheduled buses and shared-ride vans and black car limousine services. The majority of scheduled shared-ride carriers use a combination of 15- to 40-passenger vehicles and 40+ passenger coach buses. Scheduled express bus service is offered by several privately-operated carriers from outlying areas of the Boston metropolitan area and neighboring states. Courtesy vehicle services include services between Logan Airport and many hotels in the Greater Boston area. Shared-ride vans also provide service from central and western Massachusetts and other regional points throughout New England.

As shown in **Table 5-4**, the estimated total number of seats provided by these HOV modes decreased by about 12 percent in 2017 compared to 2016. The increased use of TNCs over the past few years has substantially reduced the number of scheduled vans and black car limousines used for Airport transportation.

8 The MBTA ferry from Hingham/Hull to the Logan Airport Ferry Dock runs less frequently and is less consistent than Blue Line and Silver Line services throughout the day. Frequencies between ferries range from one hour to several hours. There are 14 MBTA ferries to and from Logan Airport on weekdays; however, there are no MBTA ferries direct to Logan Airport from the South Shore during morning commuting times.

9 As of 2019, the Hingham/Hull fare has been reduced to $9.25.

Table 5-4 Other Scheduled and Unscheduled HOV Modes: Scheduled Buses, Shared-Ride Vans, Courtesy Vehicles, and Black Car Limousines, 2010–2017

	Estimated Seats			
Year	**Scheduled Buses**	**Scheduled Vans & Limousines**	**Courtesy Vehicles**	**Limousines (unscheduled)**
2010	2,345,145	893,992	2,021,415	1,882,172
2011	2,251,480	996,208	1,885,575	1,991,672
2012	2,360,050	656,288	2,071,545	2,180,020
2013	2,342,450	437,344	2,043,870	2,125,044
2014	2,332,110	311,680	2,092,965	2,739,464
2015	2,324,080	499,344	2,118,810	3,277,000
2016	2,754,290	640,586	2,583,345	4,203,915
2017	2,969,395	385,221	3,057,645	2,528,057
Percent Change (2016 - 2017)	**7.8%**	**(39.9%)**	**18.4%**	**(39.8%)**

Source: Massport.

Pedestrian Facilities and Bicycle Parking

Massport provides a significant Airport-wide pedestrian network that links the terminals as well as linking Logan Airport to the neighboring community. Sidewalks along Harborside Drive and Hotel Drive connect to the terminals, where a series of overhead, enclosed walkways provide pedestrian access to the Central and West Parking garages as well as to and from the Hilton Hotel. The sidewalks along Harborside Drive, Transportation Way, North Service Road, and the Harborwalk facilitate pedestrian access to the Airport water shuttle boat dock, MBTA Blue Line Airport Station, and the pedestrian and bicycle pathways at Memorial Stadium Park, Bremen Street Park, and the East Boston Greenway.

Bicycle parking racks are provided at many landside facilities. Generally, these racks are expected to primarily serve employees but are open for use by air passengers as well. Terminal A, Terminal E, the Logan Office Center, Signature General Aviation Terminal, the Economy Parking Garage, the Green Bus Depot, and the Airport MBTA Station all have bicycle racks. The Rental Car Center has sheltered bicycle parking racks for use by both employees and passengers. Shower and changing facilities are provided at the Logan Office Center for employees.

Bicycle parking at Massport facilities. Source: Massport.

There are pedestrian and bike counters along the Greenway Connector. In 2017, there were 63,915 East Boston Greenway users recorded by the counter compared to 43,787 in 2016.

Non-HOV Modes

Logan Airport passengers can access the Airport by a number of automobile modes, including private automobiles, taxis, TNCs, and rental cars. Although these modes have been historically categorized as non-HOV, they frequently carry more than one passenger per vehicle.

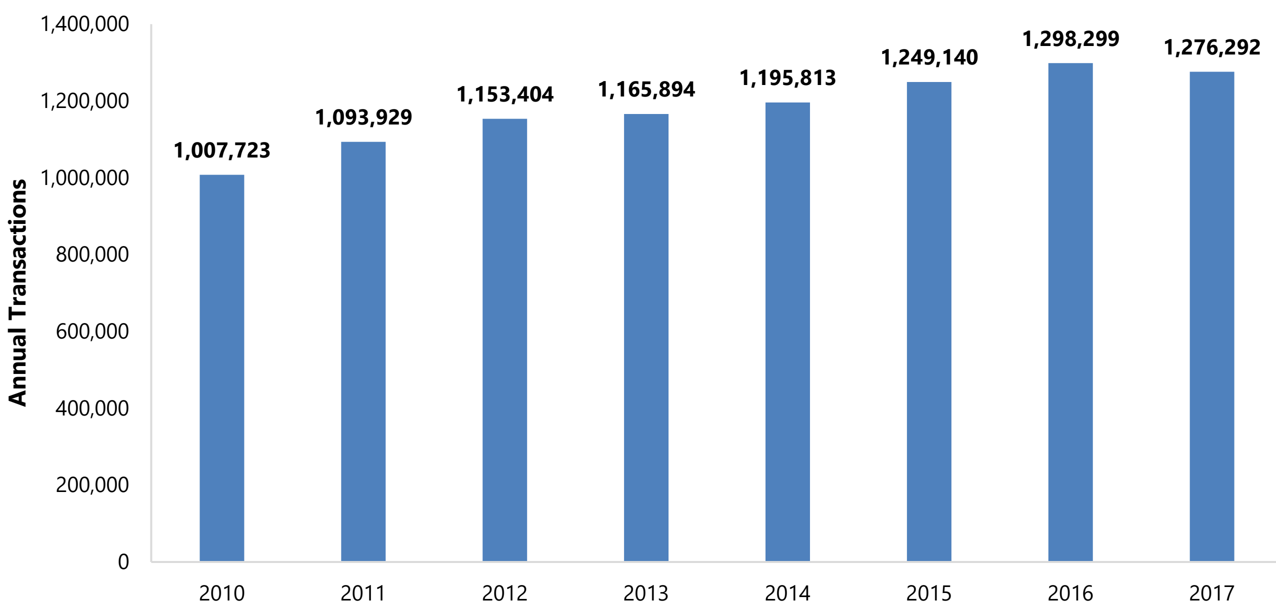
Automobile Access

Private automobile access to the Airport is classified as either curbside drop-off or parked-on-Airport (terminal area or remote/Economy). Volumes and VMT associated with these trips are described in this chapter's section on traffic conditions.

Rental Cars

Eleven rental car brands served Logan Airport in 2017: Advantage, Alamo, Avis, Budget, Dollar, Enterprise, Hertz, National, Thrifty, Payless, and Firefly. Zipcar also provides services from the rental car facility. Although a slight decrease was noted in 2017, rental car transactions (see **Figure 5-5**) have been increasing in recent years, following the trend of increasing air passenger activity.

Figure 5-5 Annual Rental Car Transactions at Logan Airport, 2010–2017

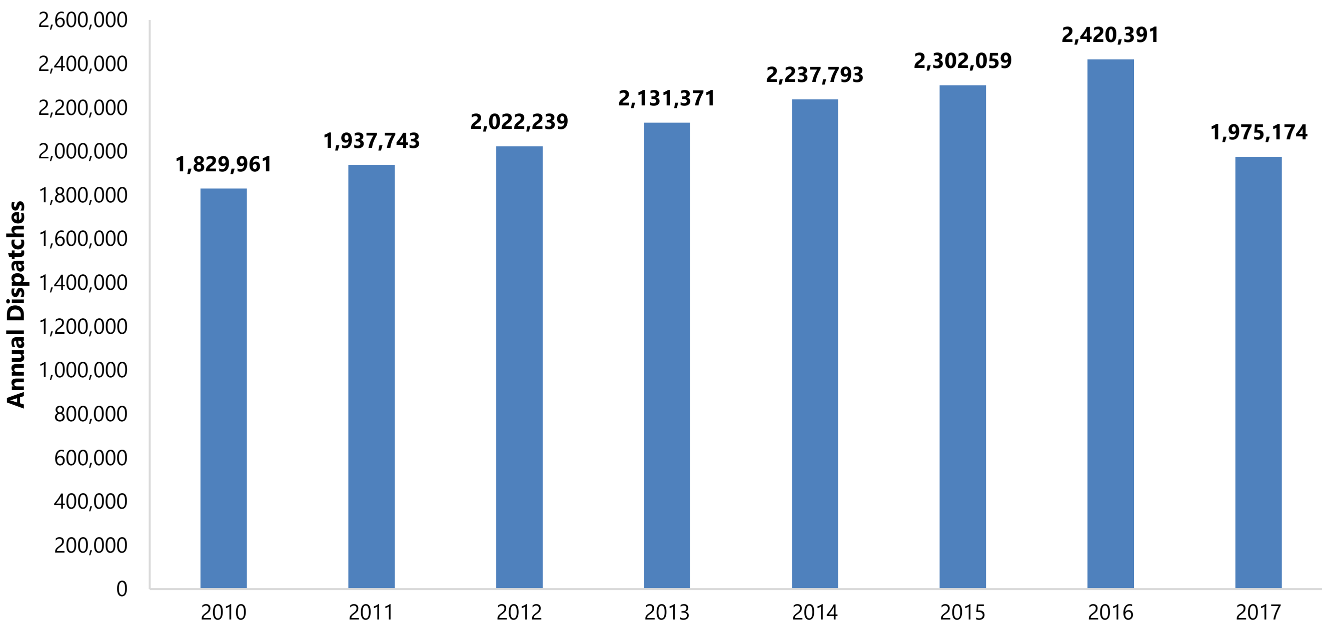


Source: Massport.

Taxis and TNCs

Taxi ridership trends are reflected in the total number of taxis dispatched from Logan Airport (serving outbound passengers). The number of taxis dispatched declined in 2017 by 18.4 percent compared to the 2016 level (see **Figure 5-6**) and may be attributed to an increase in TNC operations at the Airport. While annual TNC ride data are not available for 2017, TNCs such as Uber and Lyft are estimated to have contributed about 15,000 vehicle trips per day. Future EDRs will report on annual TNC ride data, which have demonstrated substantial growth in TNC operations since 2017 at the Airport. To address congestion issues caused by TNCs, Massport is reconstructing the ground floor of the Central/West garage to facilitate passenger drop-off (between the hours of 10:00 AM and midnight) and pick-up (all times). This service change is expected to be complete by October 2019.

Figure 5-6 Annual Taxi Dispatches at Logan Airport, 2010-2017



Source: Massport.

Clean Air Cab Program

Since 2007, Massport has sponsored a "Head-of-Line" hybrid vehicle taxi incentive program, in partnership with the City of Boston. Under this program, Boston taxis that qualify as clean-fuel vehicles may obtain permission to move up in the line at Logan Airport's taxi pool; this allows these vehicles to be dispatched to the terminals in a shorter amount of time.

2017 Parking Conditions

Massport manages the on-Airport parking supply at Logan Airport to promote long-term rather than short-term parking (thus reducing the number of daily trips to Logan Airport); support efficient use of parking facilities; provide good customer service; and comply with the provisions of the Logan Airport

Parking Freeze. Logan Airport contains multiple parking facilities, including the Central Parking Garage (convenient access to Terminals A, B,C, and E), Terminal B Garage, Terminal E Parking Lots, and Economy Garage (free shuttle bus service to and from the terminals 24 hours a day). Details on 2017 parking conditions are presented in the following sections.

Massport has a comprehensive parking monitoring and management program including tracking of:

- On-Airport parking conditions, including parking facilities and supply, demand, and parking rates; and
- Parking programs (including preferred parking for hybrid vehicles and electric car charging stations).

Logan Airport Parking Freeze and On-Airport Parking Availability

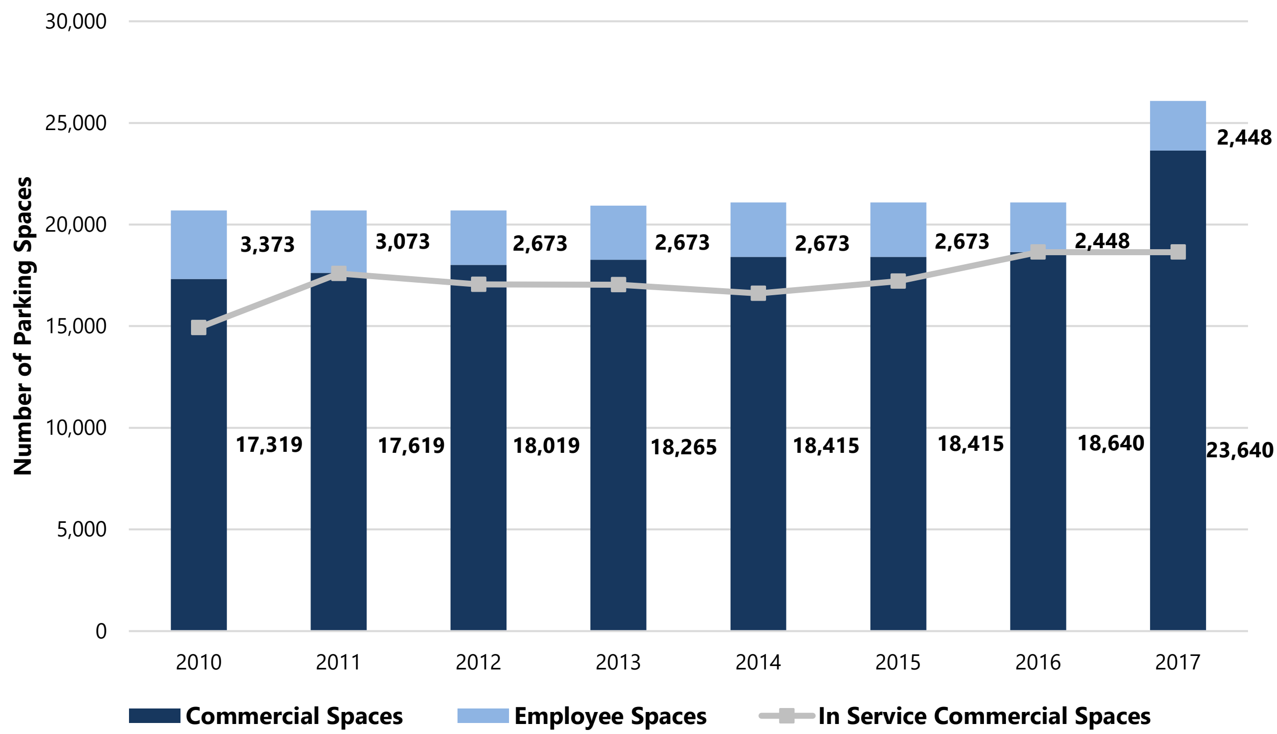
The number of commercial and employee parking spaces allowed at Logan Airport is regulated by the Logan Airport Parking Freeze (310 Code of Massachusetts Regulations 7.30), which is an element of the Massachusetts State Implementation Plan (SIP) under the Federal Clean Air Act (42 U.S.C. §7401 et seq. [1970]). As required, Massport submits semi-annual filings to the Massachusetts Department of Environmental Protection (MassDEP) demonstrating Massport's compliance with the Logan Airport Parking Freeze. The full reports for March, September, and October[10] of 2017 are provided in Appendix G, *Ground Access*. All reports (September 2012 through March 2019) are available online. Total in-service commercial spaces are illustrated in **Figure 5-7**, along with the total number of parking spaces permitted on-Airport and the allocation of those spaces between commercial and employee spaces through 2017. Construction on the Airport and shifting of total spaces from one area to another (as discussed further below) account for the fluctuation of in-service spaces from year to year.

The Logan Airport Parking Freeze sets an upper limit to the supply of commercial and employee parking spaces at Logan Airport. As permitted (and encouraged) by the Parking Freeze provisions, Massport has converted employee spaces to commercial spaces, within the overall limit imposed by the Logan Airport Parking Freeze. Massport has also transferred Airport-related park-and-fly spaces managed under the East Boston Parking Freeze[11] to be managed under the Logan Airport Parking Freeze.

10 The October 2017 report replaces the September 2017 report.

11 310 Code of Massachusetts Regulations 7.31.

Figure 5-7 Allocation of On-Airport Parking Spaces



Source: Massport.
1 In 2011, 700 employee spaces were converted to commercial spaces under the Logan Airport Parking Freeze.
2 In July 2012 and June 2013, Massport acquired property in East Boston that reallocated 396 park-and-fly spaces from the East Boston Parking Freeze area to the Logan Airport Parking Freeze area.
3 In 2016, Massport opened the West Garage Expansion, reallocating 225 employee spaces to commercial and increasing the total number of in-service spaces.
4 In 2017, MassDEP approved an additional 5,000 parking spaces. The first 2,000 spaces are anticipated to be in service by 2022.

As one element of its comprehensive transportation strategy, Massport proposed to amend the Logan Airport Parking Freeze to allow an additional 5,000 on-Airport commercial parking spaces at Logan Airport, with a goal of providing Massport with the ability to reduce the number of air passengers choosing more environmentally harmful drop-off/pick-up modes by allowing passengers to park on-Airport. MassDEP issued the amended regulation on June 30, 2017, approving the requested Parking Freeze increase. Massport initiated a parallel process with the Executive Office of Energy and Environmental Affairs (EEA) by filing an Environmental Notification Form (ENF) for new parking facilities on March 31, 2017. On May 5, 2017, EEA issued its Certificate on the ENF, establishing the Scope for the required Draft Environmental Impact Report (EIR).

On December 5, 2017, the U.S. Environmental Protection Agency (EPA) proposed a rule approving the revision of the Massachusetts SIP incorporating the amended Logan Airport Parking Freeze. The final rule was issued on March 6, 2018 and became effective on April 5, 2018. Initiation of concept design for the facilities needed to provide 5,000 additional commercial spaces and preparation of a Draft EIR/Environmental

Assessment (EA) began in 2018. The Draft EIR/EA, published in May 2019, provides additional details on the planned construction of 2,000 spaces in a new garage in front of Terminal E and an expansion of the Economy Garage with the addition of 3,000 spaces. See Chapter 3, *Airport Planning*, for additional information on this project.

Under the Logan Airport Parking Freeze regulation, Massport must monitor the number of commercial and employee vehicles parked on-Airport and ensure that the total number of parked commercial and employee vehicles does not exceed the Parking Freeze limits. If the number of commercially parked vehicles exceeds the allocated commercial parking limit under the Parking Freeze on any day, those additional vehicles are considered to be using "Restricted Use Parking Spaces." Use of Restricted Use Parking Spaces is allowed under the regulation when Logan Airport experiences "extreme peaks of air travel and corresponding demand for parking spaces" and may be made available for use only at such times, up to ten days in any calendar year. These spaces must be provided free of charge when demand exceeds the limit.

The intent of the Logan Airport Parking Freeze is to reduce air emissions by shifting air passengers to travel modes requiring fewer vehicle trips. However, survey data since the 1970s has consistently shown that constrained parking has the unintended consequence of shifting air passengers to travel modes with higher numbers of vehicle trips (and thus is more environmentally harmful), despite Massport's extensive efforts to provide and encourage the use of HOV travel modes. According to the *2016 Logan Airport Air Passenger Ground-Access Survey,* if parking was not an option for passengers who parked on-Airport, 77 percent of survey respondents indicated that they would use drop-off/pick-up modes (i.e., dropped off or picked up by private vehicles, taxi, TNC, or black car limousine service). Prior surveys of Logan Airport air passengers have consistently shown similar results.

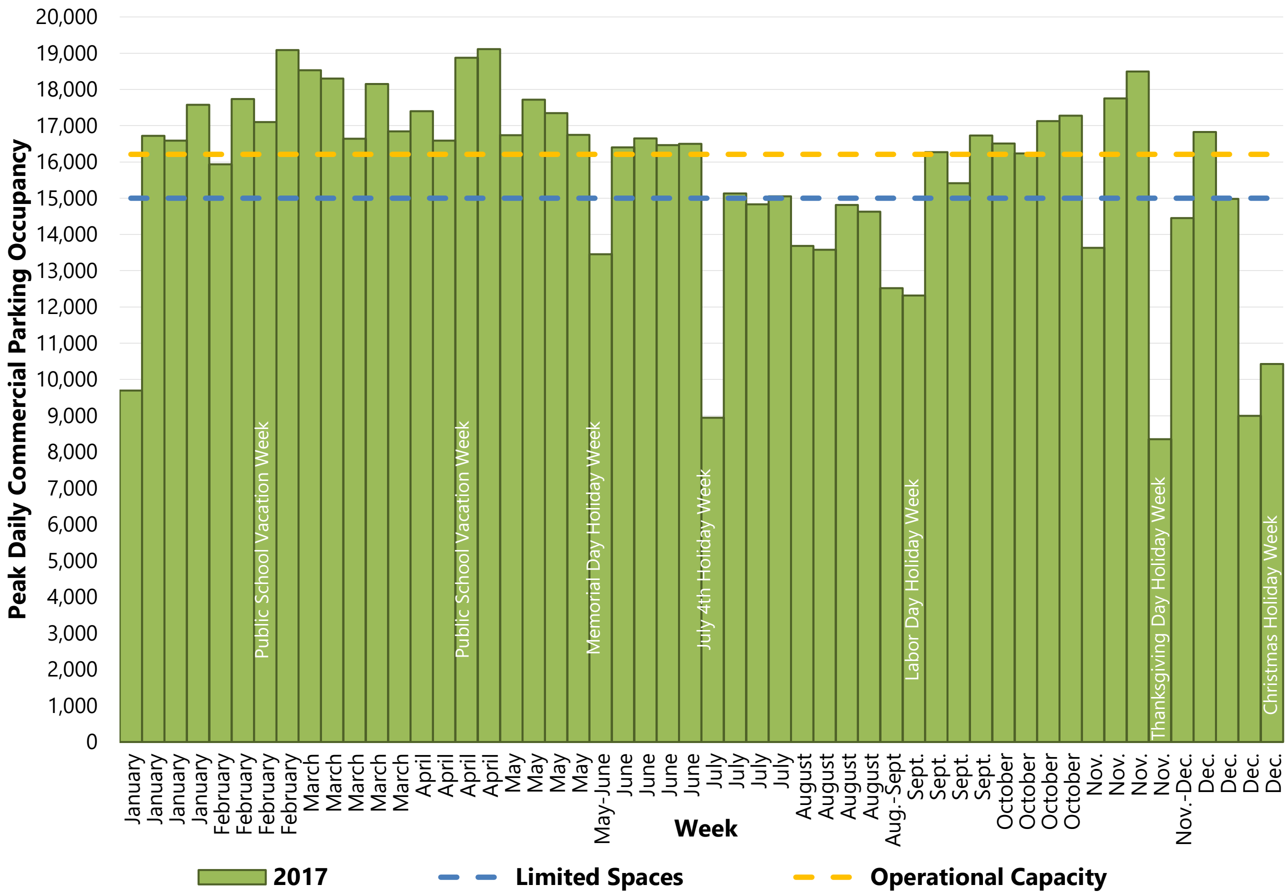
Daily Parking Occupancy

On-Airport commercial parking occupancy typically peaks mid-week (Tuesday through Thursday) with lower occupancies occurring Friday through Monday. The number of vehicles parked at Logan Airport in commercial spaces over the course of any 24-hour period was obtained from parked vehicle count data for Tuesdays, Wednesdays, and Thursdays, which are collected throughout the year. The peak daily parking occupancy data are presented in **Figure 5-8**.

Peak day demand for on-Airport parking has been increasing, resulting in daily demand frequently nearing the previous Logan Airport Parking Freeze limits (see **Figures 5-8** and **5-9**). While Massport continued to be in full compliance with the Logan Airport Parking Freeze,[12] in 2017 it was forced to divert vehicles to overflow lots or valet-park passenger vehicles on 81 out of 260 working days. Vehicle diversions primarily occurred on Tuesdays and Wednesdays during hours of peak parking demand.

12 310 Code of Massachusetts Regulations 7.30 and 40 Code of Federal Regulations 52.1120.

Figure 5-8 Commercial Parking: Weekly Peak Daily Occupancy, 2017

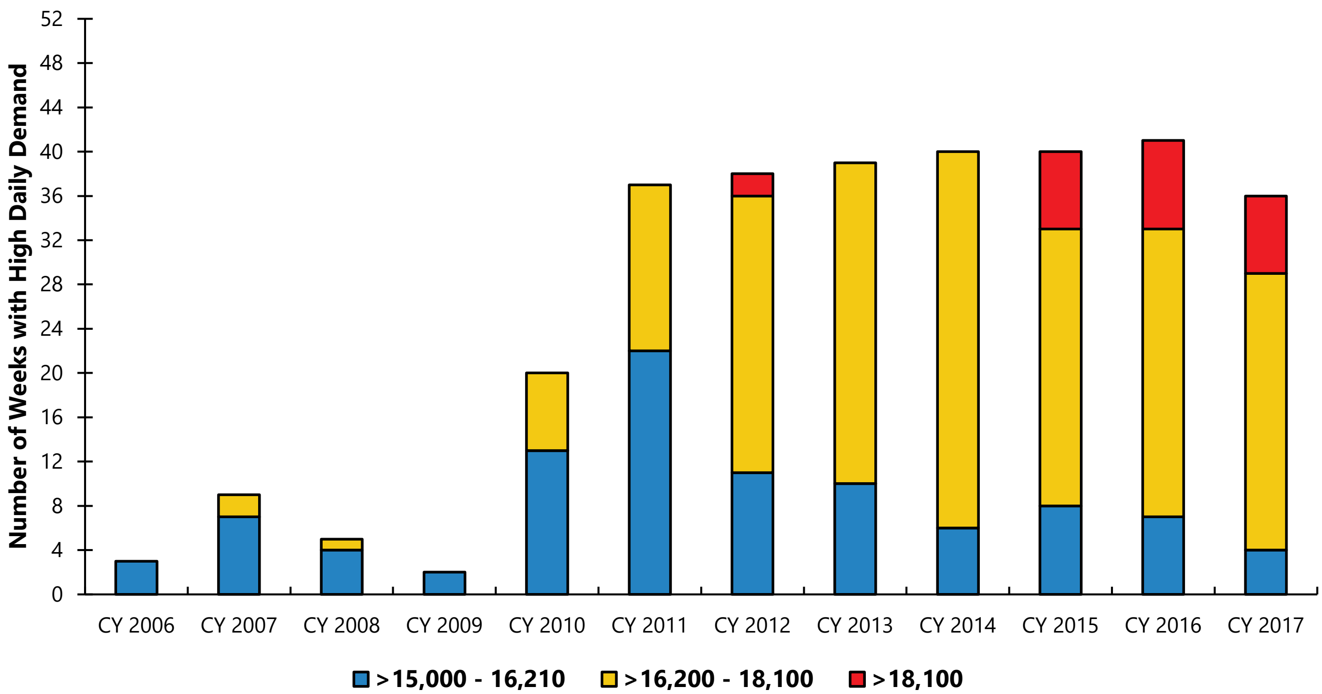


Source: Massport.
Notes: The chart shows the highest daily count for each week in 2017.
At no time in 2017 did the Parking Freeze limit on Restricted Use Spaces exceed the allowed 10 days. Massport was at all times in full compliance with the Parking Freeze regulations in 2017.

Operational Adjustments to Meet Parking Demand

The inadequate supply of parking causes air passengers to circulate on Airport roadways to find parking. In overflow conditions, cars are diverted or moved to non-garage parking areas, including overflow lots, some of which are located off-Airport. These factors contribute to an increase of on- and off-Airport VMT. Not only does parking demand activity above capacity lower customer service levels, it also increases on-Airport roadway vehicle emissions related to circulating traffic. Diversions and valeting have become a regular occurrence at Logan Airport. These diversions decrease operational efficiency and compromise customer service; as well as increase on-Airport VMT by generating additional on-Airport trips that would otherwise be unnecessary under uncongested conditions.

Figure 5-9 Demand for Parking: Number of Weeks per Calendar Year with High Daily Parking Demand



Source: Massport.

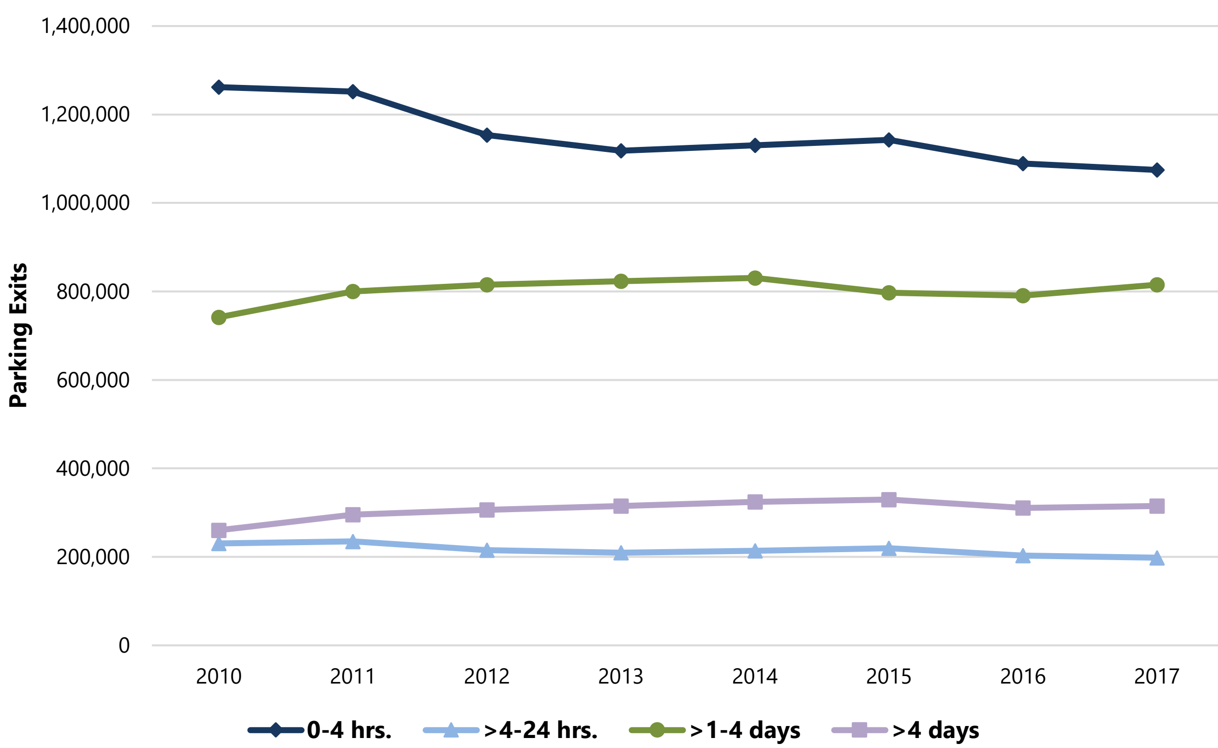
Figure 5-10 2017 Parking Demand and Capacity

Source: Massport.
Notes: 18,100 represents the total number of lined on-Airport parking spaces allocated in 2017. Hotel and general aviation uses, which are included in the Parking Freeze Limit, are excluded from this figure. Current commercial Parking Freeze limit is 23,640.

Parking Exits by Duration

As presented in **Figure 5-11**, the total annual parking activity (as defined by revenue parking exits) remained relatively constant in 2017. While short-term parking has been trending down since 2010, all other parking durations have remained relatively constant, despite unprecedented growth in air passengers. In 2017, a flat growth (less than 1 percent) in overall parking coupled with a decrease in short-term parking (1.3 percent) and an increase in the number of total vehicles entering the Airport may be a symptom of a shift to drop-off/pick-up modes (both private vehicle and TNC) because of constrained parking conditions increasing on- and off-Airport VMT. The Parking Freeze Amendment will allow Massport the flexibility to build additional parking supply in conjunction with expanding HOV alternatives in order to discourage drop-off/pick-up modes.

Figure 5-11 Parking Exits by Length of Stay (Parking Duration)



Source: Massport.
Notes: Tickets are representative of revenue parking exits. Previous data reported in 2015 and 2016 have been adjusted down to account for the unintentional inclusion of non-revenue exits.

2017 Commercial Parking Rates

Massport periodically assesses its parking rate structure to support its ground-access strategy. As detailed in **Table 5-5**, parking rates in the on-Airport garages were increased in July 2017, while the substantially lower parking rates for Logan Express remote parking have been maintained at $7 per day. Massport also

eliminated short-term 30- and 90-minute parking rates (requiring customers to pay for the entire hour regardless of duration inside the garage) and the weekly economy rate for economy parkers, which previously offered a substantial reduction to long-term customers. These policies contributed to growth in Logan Express suburban park-and-ride ridership by 6.2 percent since 2016.

With a pay-on-foot system, Massport requires parking fees to be pre-paid at kiosks inside the terminals and at garage access points at the pedestrian walkways, thus improving parking exit flow and reducing vehicle idling and associated emissions at exit plazas. Pay stations are located in the terminals, at the Massport shuttle drop-off/pick-up location in the Economy Garage and at the pedestrian entrances to the Central Garage, Terminal B garage, and Terminal E parking lot. Approximately 80 percent of parking patrons use the pay-on-foot system to pre-pay their parking fees before exiting.

Table 5-5 On-Airport Commercial Parking Rates, 2016-2017

	Central Parking, Terminal B Garage, Terminal E Lot Rates		Economy Rates	
	2016	2017	2016	2017
0 to 30 minutes	$3	N/A	$3	N/A
31 minutes to 1 hour	$6	N/A	$6	N/A
0 minutes to 1 hour	N/A	$7	N/A	$7
1 to 1.5 hours	$12	N/A	$11	N/A
1.5 to 2 hours	$17	N/A	$16	N/A
1 to 2 hours	N/A	$19	N/A	$18
2 to 3 hours	$22	$24	$18	$20
3 to 4 hours	$26	$28	$21	$23
4 to 24 hours	N/A	N/A	$23	$26
Additional days 0 to 6 hours	$16	$18	$12	$13
Additional days 6 to 24 hours	$32	$35	$23	$26
Weekly rate (6-7 days)	N/A	N/A	$138	N/A

Source: Massport.
Note: Most recent rates effective 2017.

Parking Programs and Initiatives

Massport has established the following programs and initiatives to support all Logan Airport users, including those picking up travelers who may have time to spare, those traveling to Logan Airport frequently, and those who are driving in environmentally-friendly vehicles.

Cell Phone Waiting Lot

The cell phone waiting lot near Terminal E provides 61 parking spaces where drivers waiting for passengers on arriving flights may park. Before the creation of the cell phone waiting lot, drivers who were waiting for arriving passengers either used short-term parking, circulated around the Airport, or dwelled at the curb until asked to move. This facility reduces vehicle emissions by minimizing idling and on-Airport VMT by such motorists. The maximum wait time permitted at this parking lot is 30 minutes, and parking is free of charge.

Parking PASSport and Parking PASSport Gold

Parking PASSport allow users to enter and exit Logan Airport's parking garages and lots with an access card that is linked to an established account for faster payment transactions. Parking fees are automatically charged to a registered credit card and the receipt is emailed to the account holder. Customers in the Parking PASSport programs account for approximately 5 percent of parking exits at Logan Airport. Parking PASSport Gold eliminates the need for a motorist to circle the garage looking for available spaces by reserving about 8 percent of spaces in the Central/West Garage and 12 percent of spaces in the Terminal B Garage for customers enrolled in the program. First implemented in 2006, the Parking PASSport Gold program decreased from 10,723 at the end of 2016 to 10,686 in December 2017.

Hybrid and Alternative Fuel Vehicle (AFV) Parking

Massport provides 173 hybrid, electric, and AFV only on-Airport parking spaces spread out among the Terminal and Economy Garage in preferred parking locations. Twenty-six of these spaces provide electric charging spaces convenient to the terminals. While normal parking rates apply, there is no cost for electricity use. Real-time availability of spaces can be found on Massport's website. Currently, there are 64 charging stations installed at Logan Airport and its Logan Express sites, with 58 additional stations planned to be installed by 2020.

Long-Term Parking Management Plan

In addition to supporting HOV, Massport actively manages parking supply as another strategy to reduce drop-off/pick-up modes. Massport manages the on-Airport parking supply at Logan Airport to: (1) promote long-term rather than short-term parking (thus reducing the number of daily trips to Logan Airport); (2) support efficient utilization of parking facilities; (3) provide good customer service; and (4) comply with the provisions of the Logan Airport Parking Freeze. Massport has substantially reduced the number of on-Airport employee spaces from over 5,000 to 2,448 to further reduce VMT and promote sustainable transportation options through a Massport-wide newsletter.

The Long-Term Parking Management Plan, which was first included in the *2012/2013 EDR,* lays out a multi-part strategy for efficiently managing parking supply, pricing, and operations—both at Logan Airport and at Massport-controlled off-Airport locations—to maximize HOV, transit, and shared-ride ground access while minimizing both drive-and-park and drop-off/pick-up modes. The Long-Term Parking Management Plan represents Massport's current strategy to manage parking pricing, supply, and demand within the current Logan Airport Parking Freeze.

Table 5-6 describes each parking plan element completed in 2017 or proposed in the near future, and progress to date. The Long-Term Parking Management Plan sets out the efforts that Massport has undertaken, and will continue to take in the future, to manage the supply, pricing, and operation of parking.

Table 5-6 Long-Term Parking Management Plan Elements and Progress

Parking Plan Element	Progress
Parking Supply:	
▪ Add revenue-controlled parking spaces in the terminal area to bring supply up to the maximum number of spaces allowed under the Logan Airport Parking Freeze.	▪ As permitted by the amended Parking Freeze, Massport is proposing to add 2,000 new commercial spaces in a new garage in front of Terminal E and 3,000 additional spaces through a vertical expansion to the Economy Garage. The new garage in front of Terminal E is anticipated to be complete by 2022 and the Economy Garage expansion in 2025. This project is consistent with the Parking Freeze.
▪ Work to increase the supply of Massport-controlled off-Airport parking at Logan Express sites.	▪ Massport plans to add up to 1,000 additional spaces to the parking garage at the Framingham site and is considering building up to 3,000 structured parking spaces at the Braintree site.
Parking Pricing:	
▪ Discourage air passengers from driving and parking at Logan Airport by ensuring that the Massport-controlled parking provided at remote Logan Express sites is the least expensive.	▪ Massport has reduced parking rates at Logan Express facilities from $11.00 per day to $7.00 per day. The least expensive parking at Logan Airport is $26.00 per day.
▪ Encourage more efficient use of available on-Airport parking by maintaining a meaningful price differential between rates at the Economy Parking Garage and terminal-area parking garages.	▪ Economy Parking is $26.00 per day in 2017; terminal-area garage and lot rates in 2017 are $35.00 per day.
▪ Evaluate increased parking prices for terminal-area parking to encourage Airport passengers and visitors to consider transit and shared-ride alternatives.	▪ Parking pricing review is ongoing.

Table 5-6 Long-Term Parking Management Plan Elements and Progress (Continued)

Parking Demand:	
▪ Increase the frequency and availability of alternative high-occupancy vehicle (HOV) mode options to decrease use of private vehicles.	▪ Massport is evaluating a number of opportunities to improve and increase Logan Express service (specific details related to these opportunities are provided elsewhere in this chapter). ▪ Massport offers discounted parking and bus fares at all Logan Express locations during peak air travel periods. ▪ Massport placed signage in all terminals to help promote the use of the regional express bus carriers. ▪ Massport continues to sponsor free outbound (from Logan Airport) Silver Line bus service and Back Bay Logan Express service. ▪ Massport continues to work with private carriers to increase HOV options to and from Logan Airport.
Employee Parking:	
▪ Continue to work to reduce the number of Airport employees commuting by private automobile and parking at the Airport by providing off-Airport parking both near Logan Airport and at Logan Express sites, and implementing measures to enhance employee commuting options.	▪ Massport provides employee parking in Chelsea with free shuttle bus transportation to the Airport. ▪ Massport offers reduced employee rates to encourage the use of Logan Express facilities. ▪ Additional early morning and late-night bus service has been added to Logan Express sites to encourage use and better serve Logan Airport employee schedules. ▪ Massport supports the Sunrise Shuttle, which provided early morning bus service for employees from East Boston and parts of Winthrop and Revere prior to the start of Massachusetts Bay Transportation Authority (MBTA) service.

Source: Massport.

Ground Access Initiatives

Massport promotes ridership on HOV, transit, and shared-ride modes and maintains efficient transportation access and parking options in and around Logan Airport to reduce the reliance on automobile modes as a means of achieving the HOV mode share goal. Measures implemented by Massport include a blend of strategies related to pricing (incentives and disincentives), service availability, service quality, marketing, and traveler information. Because of the different demographics of Logan Airport air passenger travelers, no single measure alone will accomplish the goal.

Future Passenger HOV Mode Share Goal

In this *2017 ESPR*, Massport presents a new definition of HOV, updating the definition to include the increased knowledge and data from the rapidly changing transportation landscape since the emergence of TNCs. In future air passenger ground access surveys, Massport will use an updated definition of HOV that

considers vehicle occupancy of taxi, black car limousine, and TNC modes. Previously, Massport counted all taxis and TNCs as non-HOV and all black car limousines as HOV, regardless of the number of passengers transported. Under the updated definition, taxis, black car limousines, and TNCs that carry two or more air passengers per vehicle will be defined as HOV. With this new definition, Massport has committed to a goal of 35.5 percent HOV by 2022 and 40 percent HOV by 2027.

Progress toward this goal will be measured using the air passenger ground-access survey; starting in 2019. The latest survey, which was conducted in 2016, revealed an air passenger ground access mode share of 30.5 percent for HOV and shared-ride modes, using the previous definition of HOV. This value increased 2.7 percent compared to 2013 and is roughly the same as the survey indicated in 2010. Historically, there has not been a significant shift in HOV mode share since 2004. This result demonstrates that Logan Airport has been able to maintain its HOV mode share in concert with improvements to roadway access to the Airport and despite significant increases in air passenger levels. Also, the result confirms Logan Airport to be at the top of U.S. airports with respect to HOV and shared-ride mode share.[13]

TNC Management Program

Massport initiated TNC pick-up and drop-off operations in February 2017. TNC pick-up lots were originally small employee lots that were not intended to handle thousands of daily TNC pick-ups, contributing to a long wait time for customer and vehicles backing onto terminal-area roadways (causing congestion and delays for customers). **Table 5-7** outlines the policies that Massport is considering to manage TNC operations.

Table 5-7 Massport Transportation Network Company (TNC) Management Plan

Policy	Goal
1. Rematch and Shared Ride	▪ Massport has approved changes such that TNC passengers will be dropped off or picked up at new dedicated areas in the Central Garage through climate-controlled walkways to and from the terminals, facilitating rematch and shared ride. ▪ Implement TNC rematch so drivers dropping off can more easily leave with a passenger. ▪ Introduce TNC shared ride incentives to reduce TNC vehicles through gateways by increasing vehicle occupancies.
2. TNC Fee Structure	▪ Adopt new TNC fee structure to support HOV strategies, encourage shared rides, and reduce gateway congestion.
3. Optimize TNC Operations On-Airport	▪ Introduce TNC data reporting, new emerging TNC products, new enforcement tools.

Source: Massport.

13 There is no standard aviation industry definition with respect to categorizing ground access modes as HOV versus single occupancy vehicle (SOV). While some modes (e.g., Logan Express and the Silver Line) clearly fall into the HOV mode category, the appropriate category for a black car limousine or taxi is less clear.

Employee Ground Transportation Initiatives

Airport employee transportation has different ground access considerations than passenger transportation. Airport employees often have non-traditional (and often unpredictable) working hours that are difficult to match to typical transit service hours (MBTA service typically runs from 5:00 AM to 1:00 AM). Due to the time-sensitive nature of airline operations, on-time reliability is important for employee transportation, as is flexibility during severe weather or other delays that may extend a typical employee workday or work shift.

Massport strives to reduce the number of Airport employees commuting by private automobile, enhance commuter options, and reduce traffic and parking demands at Logan Airport. To help accomplish these objectives, Massport continues to:

- Provide off-Airport employee parking in Chelsea, which is served by frequent free shuttle bus service to the terminals (Route 77) 24 hours a day, seven days a week;
- Run free employee shuttle buses between Airport Station and employment areas in the Southwest Service Area and the South Cargo Area locations (Routes 44, 66, and Logan Office Center);
- Operate early morning and late-night Logan Express bus trips for commuters;
- Support the Sunrise Shuttle for early morning bus service from East Boston, Winthrop, and Revere prior to the start of MBTA service;
- Expand and maintain a comprehensive sidewalk/walkway system on Logan Airport to facilitate pedestrian access;
- Provide employee subsidies for water transportation use;
- Provide bicycle racks;[14]
- Advise Airport employers on transit benefits and provide information on available commuting alternatives, ride-matching services, and reduced-rate HOV and transit fare options; and
- Contribute $65,000 annually to the Logan Transportation Management Association (TMA).

Ground Access in the Future Planning Horizon

In the next 10 to 15 years (the Future Planning Horizon) Logan Airport is anticipated to reach 50 million air passengers. While the sections above discuss strains placed on the Airport's roadway infrastructure at 2017 levels (38.4 million passengers) and the current (2019) trends observed on Airport roadways, the sections below discuss the policies and infrastructure changes Massport is considering to reduce congestion on Airport roadways. The importance of alleviating congestion is twofold: it allows for continued safe and efficient operation of the Airport's landside operations and it is necessary to reduce environmental impacts. Enhancing multimodal transportation options and providing modern, flexible infrastructure is one way an airport can reduce GHG emissions and improve its environmental footprint.

14 Bicycle racks are provided at Terminal A, Terminal E, Logan Office Center, MBTA's Airport Station, Economy Parking Garage (covered), Signature general aviation terminal, the Green Bus Depot (Bus Maintenance Facility), and the Rental Car Center (covered).

Potential emissions reductions are one reason Massport is committed to a long-term goal to promote and support public and private HOV and shared-ride services aimed at serving air passengers, Airport users, and employees. Other benefits include:

- Improving operations on the terminal-area roadways and at curbside drop-off/pick-up areas;
- Alleviating constraints on limited parking facilities; and
- Improving customer service (providing a range of transportation options for different traveler demographics).

The analysis described below assumes these measures have been implemented by Massport over the next decade. Specifics of the measures themselves are currently being developed and will be further documented in subsequent environmental filings and EDRs.

Future Planning Horizon VMT Estimate

The VMT analysis of the Future Planning Horizon is based on increased air passenger activity, associated increases in cargo, and planned policy changes that are anticipated over the next 10 to 15 years. The passenger level evaluated represents an increase of about 11.5 million air passengers, 93 percent of whom start or end their trip at Logan Airport and are expected to use ground transportation at the Airport (the remaining 7 percent are air passengers make connecting flights through Logan Airport and do not use ground transportation services). Massport's policy in maintaining operations to accommodate passenger levels has resulted in several ongoing studies of future conditions on ground operations. Through these studies, it has been determined that additional infrastructure modifications are needed as a complement to policy changes to allow terminal-area roadways and curbsides to continue functioning adequately and minimize vehicle idling and associated emissions. Infrastructure modifications implemented in the next 10 to 15 years may include on-Airport dedicated HOV bus lanes, the creation of an intermodal transportation center with bus service to terminals, the construction of an APM, or some combination of these improvements. It is envisioned that these changes will allow Massport to reduce VMT despite increasing passenger activity levels.

A VMT analysis was conducted for the Future Planning Horizon using the VISSIM model of Logan Airport. On-Airport vehicle trips were estimated based on available flight forecast information and anticipated mode shares. Mode share development was based on the following policy changes anticipated to be in place over the next decade:

- Increased frequencies on the Braintree Logan Express service line;
- Relocation of Back Bay Logan Express to Back Bay Station;
- A new urban Logan Express location (North Station or similar location), and potential additional locations in Metro West and on the North Shore;
- Reduced Logan Express pricing in urban areas and other service enhancements for all passengers who use Logan Express;
- Changes to TNC pricing;

- Purchase of eight additional (16 total) Silver Line buses to allow for increased frequencies; and
- Ten percent increase in private bus frequency.

Additionally, planned roadway improvements discussed in Chapter 3, *Airport Planning* (Terminal B-C roadways, Terminal E Modernization, and completion of the Logan Airport Parking Project) are assumed to be in place.

In the Future Planning Horizon, daily on-Airport VMT is estimated to be 180,000 or about 9 percent less than the 2017 daily VMT of 196,500. The decrease in VMT is attributed to the infrastructure improvements and anticipated policy changes identified above, and other possible infrastructure modifications Massport is currently considering in response to increased congestion on Airport roadways.

Future Parking Demand

As described above, on many weeks in 2017, passengers and their vehicles were periodically diverted from their primary parking choice to other locations on-Airport. Historically, the need to implement diversion and valet activities on peak days has not been dampened by parking rate increases for on-Airport parking. However, parking demand may have decreased for non-peak days, such as Fridays and Saturdays.

The Parking Freeze changes recently adopted by MassDEP and EPA will increase the parking supply and allow drive-and-park to become a more reliable mode choice to the Airport, reducing on- and off-Airport VMT. Construction of new parking garages to support the Parking Freeze changes are expected to:

- Shift "would-be parkers" from drop-off/pick-up modes to parking;
- Reduce the number of trips associated with "would-be parkers" traveling to and from Logan Airport;
- Improve on-Airport roadway and terminal curbside congestion associated with drop-off/pick-up activity;
- Improve air quality effects associated with drop-off/pick-up activity by increasing the parking supply and decreasing the number of passengers choosing drop-off/pick-up modes; and
- Enhance passenger experience by reducing the need to divert parkers to off-Airport satellite parking locations, which increases the time it takes for air passengers to drop off their cars and access the terminal area and leads to additional VMT per vehicle.

In 2017, it was estimated that roughly 7,300 vehicles entered or exited Massport's parking system on a peak summer average day. This includes all short- and long-term parkers. In the Future Planning Horizon, this number is anticipated to increase by about 33 percent to 9,700 vehicles. However, this estimate does not consider how parking might change on-Airport given the factors discussed above, including parking capacity. Massport will continue to analyze future parking demand and increased passenger activity levels in the context of changes in parking supply, on-Airport access, and new technology such as TNCs and autonomous vehicles.

Ground Access Goals

Table 5-8 lists each ground access goal and updates Massport's initiatives associated with each goal. Initiatives are planned, designed, implemented, and continuously refined to account for the changing national, regional, and local conditions that affect Logan Airport and its users.

Table 5-8 Ground Access Planning Goals and Progress (2017)

Goal	2017 Update
Increase air passenger ground-access high-occupancy vehicle (HOV) mode share to 40 percent by 2027	Massport continues to provide and actively promote numerous HOV and shared-ride options to air passengers, including Logan Express bus service, the Silver Line, water shuttle services, and frequent, free shuttle bus service to and from the Massachusetts Bay Transportation Authority (MBTA) Blue Line Airport Station. Massport is investigating ways to increase HOV mode share by implementing new HOV initiatives and pricing strategies. Massport is also training ground transportation personnel to encourage passengers to share rides. Logan Airport continues to be one of the top of U.S. airports in terms of HOV and transit mode share. In future air passenger ground access surveys, Massport will use an updated HOV definition where vehicle occupancies of taxis, black car limousines, and TNCs that exceed one air passenger per vehicle will be considered HOV, while the same modes with one air passenger will count as non-HOV. With this updated definition, Massport has committed to a goal of 35.5 percent HOV by 2022 and 40 percent by 2027. Massport continues its partnership with the MBTA to offer free boardings of the Silver Line bus at the Airport. The promising results of reduced dwell times and faster travel times through the terminal area led Massport to extend the free-fare program indefinitely. Eight Silver Line buses purchased by Massport are operated by the MBTA with Massport paying operating costs for the Silver Line buses. In 2017, Massport funded mid-life rebuilds of four Silver Line buses and rebuilt four additional buses in 2018. Massport plans to purchase eight additional Silver Line buses, bringing its total to 16 buses, to increase frequencies and service. In 2019, Massport is improving Back Bay Logan Express Service by changing the location of the stop at Copley to the MBTA Back Bay Station; discounting one-way fares from $7.50 to $3 (return fares will be free); piloting a priority security line status for riders; executing a marketing campaign to support increased ridership; and implementing Logan Express electronic ticketing. Massport is investing in existing suburban Logan Express sites by increasing the Braintree Logan Express service from two to three trips per hour.
	Massport plans to add approximately 1,000 additional spaces to the Framingham site's garage to accommodate current and future demand. Massport also plans to build up to 3,000 structured parking spaces at the Braintree Logan Express site. Massport plans to offer a new urban Logan Express service at North Station in 2020. This service would be free from Logan Airport and $3 to Logan Airport, and have three trips per hour. A security line priority status would be provided to North Station Logan Express riders and electronic ticketing would be implemented.

Table 5-8 Ground Access Planning Goals and Progress (2017) (Continued)

Goal	2017 Update
Reduce employee reliance on commuting alone by private automobile	Massport continues to support the Logan Transportation Management Association (TMA) with $65,000 annually (no dues are collected from Airport employers). Massport uses funds from the Logan TMA to operate the two early morning Sunrise Shuttle services that serve East Boston, Winthrop, and Revere. Massport continues to provide outreach to employees about commute options. For employees who reside in neighborhoods and communities closer to the Airport, bicycle parking options have increased with bicycle racks offered at Terminal A, Terminal E, the Economy Garage, the Green Bus Depot, the Rental Car Center, the Logan Office Center, and the Signature general aviation terminal. Massport is also investigating ways to improve bicycle access to/around Logan Airport facilities.
Reduce congestion related to increasing use of Transportation Network Companies (TNCs)	In the near term, Massport is relocating most TNC drop-off/pick-up activity to the ground floor of the Central Parking Garage complex, with the exception of drop-off at terminal curbs during the 4:00 to 10:00 AM peak departure period. This area will provide weather-protected, climate-controlled areas for passengers, including wheelchair assistance, curbside baggage check, and other amenities. Massport is identifying specific curbside locations at each terminal for drop-off/pick-up for convenient accommodations for persons with disabilities.
Increase the overall efficiency of the metropolitan transportation system through interagency coordination	Massport participates in the Boston Metropolitan Planning Organization (MPO) to promote planning and funding of transportation system options that enhance access to the Airport. Massport and the MBTA have worked together on several initiatives including the renovated Blue Line Airport Station and the Silver Line bus service to Logan Airport. Massport has also partnered with the MBTA, the Massachusetts Department of Transportation (MassDOT), the City of Boston, and the Convention Center Authority in implementing transportation improvement plans recommended in the South Boston Waterfront, including sustainable transportation plans, as a means to improve the MBTA Silver Line access between South Station, the South Boston Waterfront, and the Airport.
Improve management of on-Airport ground access and infrastructure through technology	Massport disseminates ground access and parking information through the Internet (www.massport.com), social media (Twitter and Facebook), a toll-free telephone number (1-800-23-LOGAN), Smartraveler, and in-Airport kiosks. Massport's redesigned website has an interactive tool that helps users access Logan Airport, while providing multimodal options.

Source: Massport.

6

Noise Abatement

Key Findings
■ The Massachusetts Port Authority (Massport) is encouraging retrofitting the Airbus A319/320/321 family with vortex generators, which reduce tonal noise on approach. United Airlines announced it was retrofitting its aircraft in 2017 as they went in for service. In a press release in October 2018, jetBlue Airways (the largest air carrier operator at Logan Airport) announced plans to retrofit its older Airbus fleet with vortex generators.
■ The fleet mix of aircraft at Boston Logan International Airport (Logan Airport or the Airport) continues to be composed of aircraft types with the quietest available technology (Stage 5 is the quietest). About 18 percent of 2017 operations were conducted in aircraft meeting Stage 5 requirements, 80 percent meeting Stage 4 requirements, and 2 percent in Certified Stage 3. In the Future Planning Horizon, which assumes 50 million annual air passengers and about 486,000 operations in the next 10 to 15 years, the fleet will be approximately 56 percent Stage 5, 43 percent Stage 4, and 2 percent Stage 3 aircraft. The expected modernization of the fleet mix and forecast day/night split is expected to moderate the effect of the forecast increase in aircraft operations.
■ Massport and the Federal Aviation Administration (FAA) are working with the Massachusetts Institute of Technology (MIT) to identify opportunities to reduce noise through changes to performance-based navigation (PBN), including area navigation (RNAV). This is a first-in-the-nation project between the FAA and an airport operator to better understand the implications of PBN and evaluate strategies to address community concerns.
■ Massport continues to be a national leader in sound insulation mitigation. To date, Massport has provided sound insulation for a total of 36 schools and 11,515 residential units and will continue to seek funding for mitigation for properties that are eligible and whose owners have chosen to participate.
■ The 2017 Day-Night Average Sound Level (DNL) contour is similar in shape and size to that for 2016, with slight increases overall. The total number of people residing within the DNL 65 decibel (dB) contour increased from 7,450 in 2016 to 7,933 in 2017, an increase of 483 people. The additional population within the DNL 65 dB contour is mainly located in Chelsea and in the area of East Boston between the Runway 15R and Runway 22R ends. This increase is primarily due to the increase in Runway 33L departures. Changes in runway use, primarily due to the Runway 4R closure, and an increase in nighttime operations were also contributors to changes in the number of people exposed to DNL values greater than or equal to 65 dB in 2017.
■ Nighttime operations represent 15 percent of total operations for 2017 at Logan Airport. Nighttime operations increased, from an average of 152 per night in 2016 to 168 in 2017. The majority (82 percent) of nighttime operations occurred either before midnight or after 5:00 AM.
■ In the Future Planning Horizon, the DNL 65 dB contour expands in certain areas due to the expected growth in number of operations. The total number of people residing within the DNL 65 dB contour is expected to increase from 7,933 in 2017 to 8,356 in the future, an increase of 423 people, all within areas already sound-insulated by Massport or eligible for sound insulation in the past. Compared to 1990, the total number of people residing in the DNL 65 dB contour is about 82 percent lower and 81 percent lower in 2017 and the Future Planning Horizon, respectively, due to improved engine technology.

Introduction

Massport strives to minimize the noise effects of Logan Airport operations on its neighbors through a variety of noise abatement programs, procedures, studies, and other tools. At Logan Airport, Massport implements one of the longest standing and most extensive noise abatement programs of any airport in the nation. Massport's comprehensive noise abatement program includes a dedicated Noise Abatement Office; a state-of-the-art Noise and Operations Monitoring System (NOMS); extensive residential and school sound insulation programs; time of day and runway restrictions for noisier aircraft; ground run-up procedures; and flight tracks designed to optimize over-water operations (especially during nighttime hours). The public can register noise complaints by phone or online through Massport's website.[1]

Massport's Noise Abatement Office is responsible for implementing noise abatement measures and generally monitoring community complaints and other aspects of the noise effects from Logan Airport operations. In addition to the initiatives listed above, highlights of activities that Massport has pursued as part of its noise program include:

- Encouraging retrofitting the Airbus A319/320/321 family of aircraft with vortex generators, which reduce tonal noise on approach.[2] United Airlines announced it was retrofitting its aircraft in 2017 as they went in for service. In a press release in October 2018, jetBlue Airways (the largest air carrier operator at Logan Airport) announced plans to retrofit its older Airbus fleet with Vortex Generators (**Figure 6-1**). These changes reflect the partnership between Massport and the airlines to reduce aircraft noise to benefit surrounding communities. As airlines retrofit aircraft and transition to the newer models of the A320 family, the number of aircraft operating at Logan Airport without the vortex generators is expected to decrease. See the section below and press release in this section below.
- Encouraging voluntary use of reduced-engine taxiing when appropriate and safe.
- Continuing improvement of the Noise Monitoring System and going out to bid for an upgraded system.
- Continuing prohibitions on use of Runway 4L for departures and Runway 22R for arrivals between 11:00 PM and 6:00 AM.
- Continuing efforts to maximize late-night over-water operations. Use of Runway 15R for departures and Runway 33L for arrivals continued.
- Continuing restriction on nighttime engine run-ups and use of auxiliary power units (APUs).

This chapter describes the runway use, fleet mix, level of operations, noise levels, and modeled noise conditions at Logan Airport related to aircraft operations during 2017 and compares the findings to those for 2016 and selected prior years. In addition, the anticipated conditions in the Future Planning Horizon of 50 million annual air passengers (10- to 15-year timeframe) model expected changes to the noise environment.

1 Massport. Noise Complaints. http://www.massport.com/logan-airport/about-logan/noise-abatement/complaints/.

2 A vortex generator is a small device that disrupts wind over ports on the wing. Without the device, the wind can produce a "whistling" tone during the aircraft's approach into an airport.

Chapter 2, *Activity Levels,* and Appendix E, *Activity Levels,* present detailed information on the development of the long-range forecast.

Noise conditions for 2017 and the Future Planning Horizon were assessed primarily through detailed computer modeling, supplemented by the analysis of measured noise levels from Logan Airport's noise monitoring system. This *2017 Environmental Status and Planning Report (ESPR)* provides information on noise conditions modeled using the latest FAA noise modeling software, the Aviation Environmental Design Tool (AEDT). Massport transitioned to AEDT from the Integrated Noise Model (INM) in its *2016 Environmental Data Report (EDR)*. As noted in that document, the AEDT modeling did not include the suite of customized adjustments historically applied to INM for accurate modeling of the unique Logan Airport environment.[3] However, the FAA did concur with the use of annual weather data and Logan Airport-specific aircraft stage length adjustments. These adjustments resulted in smaller differences between the INM and AEDT contours under the defined flight paths, but larger differences along the sides of the runways, especially close to Logan Airport. The same holds true for the 2017 contours. Since the *2016 EDR*, AEDT version 2c has been updated and replaced with AEDT version 2d. The differences between model versions pertain largely to air quality modeling; except for the addition of a few new aircraft types, noise results are effectively the same.

Noise analysis results include annual DNL noise contours and estimates of the population residing within various increments of noise exposure for 2017 and the Future Planning Horizon. This chapter also includes a comparison of the modeled results with measured levels for 2017 from the noise monitoring system. Supplemental noise metrics include Logan Airport's Cumulative Noise Index (CNI), Time Above (TA) various threshold sound levels, and periods of dwell and persistence of noise levels to provide a better understanding of the noise environment. Massport also provides a progress report on ongoing noise abatement measures and any new noise abatement initiatives affecting Logan Airport.

Appendix H, *Noise Abatement*, provides historical details on aircraft operations, runway use, noise-exposed population, and status of the sound insulation program since 1990. Total runway use from all operations, usage by runway end, and DNL levels at U.S. Census Block group locations are included. Appendix H also contains the *Flight Track Monitoring Report* for 2017 and a *Fundamentals of Acoustics and Environmental Noise* section, which gives an overview of key noise issues, noise metric definition, and terminology for the general reader.

3 Massport's communications with the Federal Aviation Administration (FAA) regarding Logan Airport's specific noise modeling methodology and ongoing research through the Airport Cooperative Research Program (ACRP) are described in Appendix H.

Figure 6-1a jetBlue Airways Vortex Generator Press Release

East Boston Times-Free Press

East Boston Massachusetts Newspaper

NEWS

Massport and Community Applaud JetBlue's Plans to Retrofit Airbus Fleet with Noise Reducing Generators

by Times Staff • October 17, 2018 • 0 Comments

Last week, JetBlue announced plans to retrofit their entire Airbus fleet with noise-reducing vortex generators. JetBlue is the largest operator at Logan International Airport and this move reflects the partnership between Massport and the airline to reduce aircraft noise to benefit surrounding communities. Massport understands concerns about aircraft noise and has continuously been involved in community discussions with residents and elected officials regarding overflights.

"While the airline industry has benefited from advances in technology and efficiency leading to quieter planes and engines, the work is never done," said Joe Bertapelle, Director Strategic Airspace Programs, JetBlue. "We're pleased to incorporate this advancement across our Airbus fleet and contribute to our communities in a meaningful way as good corporate citizens."
Beginning in 2015, the airline began taking delivery of new aircraft with vortex generators already installed as standard equipped Airbus family aircraft. JetBlue is committing to add the devices to its 138 remaining Airbus A320 family aircraft through 2021. The small devices disrupt wind over ports on the wing, which can produce a "whistling" tone during approach into an airport.

Vortex generators will be installed on 130 existing JetBlue A320 aircraft and 8 JetBlue A321 aircraft during their existing scheduled heavy checks with the full fleet wide install expected to be complete in 2021. All future Airbus orders will be delivered with vortex generators already installed.

This extraordinary commitment is a testament to years of advocacy by local elected officials, and JetBlue's ongoing support for the communities where its customers and crewmembers live and work, paralleled JetBlue's own research on the effectiveness of vortex generators.

Figure 6-1b jetBlue Airways Vortex Generator Press Release

"Thank you to JetBlue for its leadership in implementing noise-reduction technologies to its entire Airbus fleet," said House Speaker Robert DeLeo. "I'm encouraged that the airline is taking this important step on this issue- one I have advocated for since I was a municipal official. I encourage the other airlines that fly in and out of Logan Airport to follow JetBlue's example."

Working with the community and elected officials, Massport has made efforts over the years in various areas to mitigate the effects of aircraft noise. Currently, Massport and the FAA are working on a groundbreaking RNAV Study led by technical experts at MIT to develop test projects to determine the possibility of noise reducing procedures at Logan. Working with the public and the statutorily created Massport Community Advisory Committee (Massport CAC), Massport has completed an initial phase called Block 1 and are in Block 2. Block 1 resulted in recommendations, which were technically less complex and did not result in shifting of noise from one community to another. Block 2 is looking at ideas that are more complex and that may shift noise.

"JetBlue's new technology to reduce airplane noise will have a positive impact on the communities impacted by flights arriving at Logan," said Senator Joseph Boncore. "This is a great move for the airline and a win for those who have advocated on this issue over the years."

"I'm pleased with JetBlue's efforts to implement noise-reduction technology across its Airbus fleet," Rep. Adrian Madaro said. "Noise pollution has long been a top quality of life concern for residents of East Boston. This investment is a step in the right direction and I implore other airlines to make noise reduction a priority as well."

The Massport CAC spearheaded that Massport prioritize this noise reduction implementation.

In December of 2015, East Boston resident John Nucci was named by Boston Mayor Marty Walsh as a representative of the City of Boston to the Massport CAC That committee unanimously elected him as their appointment to the Massport Board of Directors.

"As a lifelong resident of East Boston, I know how important it is that Massport push the airlines to develop noise reducing benefits for the surrounding communities," said Massport CAC member and Board member John Nucci. "After hearing from the membership of the Massport CAC, as their appointment to the Massport Board, I was pleased to advocate for the retrofit of fleets to include noise-reducing vortex generators. JetBlue's actions are a positive outcome for all."

"At Massport, we are continuously engaged with the surrounding communities of Logan Airport and appreciate their feedback regarding airplane noise," said Massport CEO Thomas P. Glynn. "We think this is a great step JetBlue is taking toward reducing airplane noise and we are thankful to the airline for making this a priority."

Noise Metrics

The common metrics used in this chapter to describe and evaluate aircraft noise are:

- **Decibel (dB)** – dB is the unit of sound pressure level (SPL), the standard measure for sound. It is a logarithmic quantity reflecting the ratio of the pressure of the sound source of interest and a reference pressure. The range of SPL extends from about 0 dB for the quietest sounds that one can detect to about 120 dB for the loudest sounds we can hear without pain. Many sounds in our daily environment have SPL on the order of 30 to 100 dB.
- **"A"-weighted decibel (dBA)** – This metric applies frequency weighting (A-weighting) to the SPL to approximate the sensitivity of the human auditory system. Human hearing is less sensitive to both low and high frequency components of sound and most sensitive to mid-frequency sounds.
- **Day-Night Average Sound Level (DNL)** – The DNL is a measure of the cumulative noise exposure over a 24-hour day. It is the 24-hour, logarithmic (or energy) average. DNL treats nighttime noise differently than daytime noise; for the A-weighted sound pressure levels occurring at night (between 10:00 PM and 7:00 AM), a 10-dB weighting is applied to the nighttime event to reflect the greater sensitivity to nighttime sound. DNL is the FAA-defined metric for evaluating noise and land use compatibility.[4]
- **Time Above (TA)** – The TA metric describes the total number of minutes that instantaneous sound levels (usually from aircraft) are above a given threshold. For example, if 65 dB is the specified threshold, the metric would be referred to as "TA65." The TA metric is typically associated with a 24-hour annual average day but can be used to represent any time period. The TA calculation can use any threshold. For this study, each of the monitoring sites report TA65, TA75, and TA85 results.
- **Effective Perceived Noise Level (EPNL)** – The EPNL calculation uses a time series of "tone corrected" perceived noise levels, reported in units of EPNdB. The tone corrected perceived noise level is determined by measuring the perceived noise level and adding to that value a "pure-tone" correction of up to 6 dB. The EPNdB is an international standard metric for the noise certification of aircraft and is part of the calculation of CNI[5] for this report.

For a more in-depth description of noise metrics, refer to Appendix H, *Noise Abatement*.

4 14 Code of Federal Regulations Part 150, Appendix A to Part 150 Noise Exposure Maps, Sec. A150.101(b).

5 Cumulative Noise Index (CNI) is a metric developed specifically for Logan Airport and defined in the Logan Airport Noise Rules. A full description of this metric and the results for 2017 are provided later in this chapter.

Regulatory Framework

Appendix H, *Noise Abatement,* provides the noise regulatory framework that this *2017 ESPR* follows. Regulations discussed include:

- *Logan Airport Noise Abatement Rules and Regulations (Noise Rules):* The Noise Rules have been in effect since 1986. The Noise Rules place restrictions on certain aircraft and ground operations by time of day and runway, subject to implementation by FAA with regard to airport and airspace safety.
- *Federal Aviation Regulation (FAR) Part 36*: This regulation specifies the metrics, methods, and reporting required for aircraft noise certification.
- *FAR Part 150*: This regulation provides a process and guidance for voluntary FAA-sponsored noise assessment and abatement programs at airports.
- *FAR Parts 91 and 161*: These regulations address noise-related restrictions on aircraft operations.

Noise Modeling Process

The sections below provide an overview of the noise modeling methodology and assumptions used in this *2017 ESPR*. For this *2017 ESPR*, Massport used the FAA required AEDT model for the noise assessment. The DNL, CNI, and TA noise metrics reported annually by Massport provide a means of understanding and comparing Logan Airport's complex noise environment from one year to the next. The numbers of operations, types of aircraft operating during the day and at night, use of various runway configurations, and the location and frequency of flight paths to and from the airport all influence the noise environment. Change in any one operational parameter from one year to the next can cause changes in the values of the noise metrics and alter the shape of the noise exposure contours that represent the accumulation of noise events during an average annual day.

Massport continues to make use of current developments in the noise modeling process each year as technologies improve. The following list provides a summary of the technologies and techniques employed in this *2017 ESPR*.

- Massport's NOMS provides all available radar data for modeling and noise measurement data for reporting.[6]
- The flight operations data from the NOMS includes detailed information with each flight record, such as aircraft registration numbers, wherever possible, which provides better AEDT aircraft type selection. This allows for the assignment of the modeled AEDT aircraft type based on the specific aircraft and engine combination used on each flight at Logan Airport during 2017.
- The modeling process includes continued use of U.S. Geological Survey digital terrain data. AEDT uses the detailed terrain data to evaluate each receptor location at its proper elevation, which enhances the accuracy of the results.

6 The noise measurement data are only used for reporting and are not used to calibrate the model.

- The population data analysis employs Geographic Information System (GIS) technology to calculate proportional estimates from U.S. Census Block data, refining the accuracy of those counts.
- Massport uses the proprietary software RC for AEDT™, an AEDT pre-processor that prepares large quantities of daily radar data for processing by AEDT. Standard AEDT analyses (without RC for AEDT™) rely on assigning all operations to a limited number of prototypical or representative tracks, apply a generalized distribution for runway usage and day/night split, and rely on other aggregated data for choice of modeled aircraft type and flight profile. RC for AEDT™ improves the precision of modeling by:
  - Automating the production of noise contours directly from each individual radar trace. In 2017, approximately 404,139 traces were collected and 394,548 retained enough information to be modeled in the RC for AEDT™ system. Each radar trace was converted to a model track, ensuring that the lateral dispersion of radar tracks was retained in the modeling. The operations on these radar traces were then scaled to account for all of the 401,371 operations in 2017.
  - Providing greater detail than standard AEDT analyses through the use of individual flight tracks taken directly from the radar system rather than relying on consolidated, representative flight tracks data.
  - Modeling each operation for the actual time of day and on the specific runway that it actually used, rather than applying a generalized distribution to broad ranges of aircraft types.
  - Selecting the specific airframe and engine combination to model, on an operation by operation basis, based on the aircraft registration or a published composition of the fleets of the specific airlines operating at Logan Airport.
  - Using each flight's origin and destination to select the proper stage length.
  - Using each aircraft's actual altitude profile to select from the available flight profiles for each aircraft type in the AEDT database.

Noise Model Inputs

Modeling for the *2017 ESPR* noise results used the most recently available version of FAA's AEDT, version 2d (AEDT 2d). Appendix H, *Noise Abatement*, contains detailed information about the noise model in the section titled *AEDT Noise Analysis*. The AEDT model requires detailed operational data as inputs for noise calculations, including numbers of operations per day by aircraft type and by time of day, as well as runway identification and flight track geometry for each flight. The Massport NOMS system provides the track and operations data for noise modeling, which incorporates the Harris NextGen radar data feed. This data feed integrates information from ground-based radar and other sensors with transponder data from aircraft. Further detail about this system is contained in the section *2017 Radar Data* in Appendix H, *Noise Abatement*.

The following section summarizes the average-day operations as used in the noise modeling and compares 2017 inputs to the previous year's data (2016).

Fleet Mix

Since 2004, Massport has relied primarily on radar data as the main source of input for noise calculations, because radar data are typically more accurate than the information reported by airlines. The radar data produces a list of approximately 500 different aircraft types that use Logan Airport during a year, including the wide variety of small corporate jets and propeller aircraft flown by general aviation (GA) users, as well as the large passenger and cargo jets operated by air carriers.

For 2017, the aircraft types identified by the radar data were matched to the AEDT 2d database, which contains individual noise and performance profiles for 282 different fixed-wing aircraft types, 167 of which represent civilian aircraft, the balance being military aircraft.[7] For those aircraft recorded in radar data that are not in the AEDT database, the radar type is paired with the best available alternative using an aircraft substitution list included in the AEDT model. The final list of modeled aircraft, used as an input to AEDT, is presented in detail in Appendix H, *Noise Abatement*.

Operations by aircraft type are summarized into several key categories: commercial (passenger and cargo) or GA operations; FAR Part 36 noise category;[8] and turboprop or propeller (non-jet) aircraft. Additionally, aircraft operations are split into daytime and nighttime periods, where nighttime hours are defined as 10:00 PM to 7:00 AM. Operations occurring during nighttime hours incur a 10-dB weighting when included in the DNL modeling calculation.

Table 6-1 summarizes the number of average daily operations by category of aircraft operating at Logan Airport in 2017 and provides comparison data for the previous two years (2015 and 2016) as well as reference years 1990, 2000, 2010, and 1998, the year of peak operations at Logan Airport. Available data for each year prior to 2015 are included in Appendix H, *Noise Abatement*.

Overall annual operations in 2017 increased by 2.6 percent compared to 2016, increasing from 391,222 operations in 2016 to 401,371 operations in 2017. When these annual figures are translated into average daily operations for noise modeling, the extra day in 2016 (a leap year) makes the comparative increase of 2.9 percent (about 1,069 operations per day in 2016 to almost 1,100 operations per day in 2017).

7 Some of the 282 aircraft in the database are military types, older Stage 1 and 2 airplanes that no longer operate in the U.S., or aircraft that do not operate at Logan Airport. There are ordinarily no military aircraft operations at Logan Airport.

8 Stage 3, 4 and 5 categories include any aircraft that meet the requirements for either Stage 3, Stage 4 or Stage 5 Federal Aviation Administration (FAA) noise categories. Note that many aircraft originally certificated as Stage 3 or Stage 4 would in fact satisfy the newer Stage 4 and 5 criteria if recertificated. FAA does not require aircraft to be recertificated and FAA has no plans at this time to restrict Stage 3 operations. Massport does not have the regulatory authority to restrict aircraft using Logan Airport.

Table 6-1 Modeled Average Daily Operations by Commercial and General Aviation (GA) Aircraft[1]

		1990[2,3]	1998	2000[4]	2010[5]	2015[5]	2016[5,7]	2017[5]	Change 2016 to 2017
Commercial Aircraft Operations (Passenger and Cargo)									
Air Carrier Jets	Day	601.3	626.4	649.0	521.6	585.6	620.5	636.0	2.5%
	Night[6]	77.2	101.5	99.8	94.0	126.4	134.9	148.8	10.2%
	Total	**678.5**	**727.8**	**748.7**	**615.6**	**711.9**	**755.4**	**784.8**	3.9%
Regional Jets	Day	N/A[2]	N/A[2]	78.1	152.6	100.4	93.2	98.4	5.6%
	Night[6]	N/A[2]	N/A[2]	3.9	13.9	4.6	7.2	9.7	34.7%
	Total	**N/A[2]**	**N/A[2]**	**82.0**	**166.6**	**105.0**	**100.4**	**108.2**	7.7%
Commercial Non-Jets	Day	444.4	552.6	409.6	138.5	125.3	125.9	119.0	(5.4%)
	Night[6]	11.7	21.9	21.6	5.2	2.4	3.0	2.2	(25.4%)
	Total	**456.1**	**574.4**	**431.2**	**143.7**	**127.7**	**128.9**	**121.3**	(5.9%)
Total Commercial Operations	Day	1,045.7	1,178.9	1,141.8	812.8	811.2	839.5	853.5	1.7%
	Night[6]	89.0	123.3	125.5	113.1	133.4	145.2	160.7	10.7%
	Total	**1,134.7**	**1,302.2**	**1,267.4**	**925.9**	**944.6**	**984.7**	**1,014.2**	3.0%
GA Aircraft Operations									
GA Jets	Day	N/A[3]	35.8	47.4	28.1	52.1	51.8	52.2	0.7%
	Night[6]	N/A[3]	4.6	3.9	3.3	4.3	4.6	4.6	(0.6%)
	Total	**N/A[3]**	**40.4**	**51.2**	**31.3**	**56.4**	**56.4**	**56.8**	0.6%
GA Non-Jets	Day	N/A[3]	37.3	34.6	8.2	19.3	25.9	26.4	1.9%
	Night[6]	N/A[3]	16.3	1.8	0.7	1.5	1.9	2.3	20.3%
	Total	**N/A[3]**	**53.57**	**36.4**	**8.9**	**20.8**	**27.8**	**28.7**	3.2%
Total GA Operations	Day	N/A[3]	73.1	81.9	36.3	71.4	77.8	78.6	1.1%
	Night[6]	N/A[3]	20.9	5.7	4.0	5.8	6.5	6.8	5.4%
	Total	**N/A[3]**	**94.0**	**87.6**	**40.2**	**77.2**	**84.2**	**85.4**	1.4%
Total Aircraft Operations									
Combined Commercial and GA	Day	1,045.7	1,252.0	1,223.8	849.0	882.6	917.3	932.1	1.6%
	Night[6]	89.0	144.2	131.2	117.1	139.1	151.6	167.5	10.5%
	Total[3]	**1,134.7**	**1,396.2**	**1,355.0**	**966.1**	**1,021.7**	**1,068.9**	**1,099.7**	2.9%

Source: Massport's Noise Monitoring System, Revenue Office and HMMH, 2019.
Notes: Totals may not add exactly due to rounding. Changes in ( ) represent a decrease.
1 Operations include scheduled and unscheduled operations. Data for other years are available in Appendix H, *Noise Abatement*.
2 Regional Jets (RJs) were not tracked separately prior to 1999.
3 Totals prior to 1998 do not include GA operations.
4 Prior to 2010, the split between air carrier jets and RJs is 100 seats with RJs having less than 100 seats.
5 After 2009, the split between air carrier jets and RJs is 90 seats with RJs having less than 90 seats.
6 Nighttime operations occur between 10:00 PM and 7:00 AM.
7 Split between GA Jets and GA Non-Jets incorrectly reported in *2016 Environmental Data Report (EDR)*; correct values shown here.

Commercial Operations

The majority of operations (approximately 92 percent) at Logan Airport are commercial flights, with the remaining approximate 8 percent GA flights. For 2017, operations by commercial air carrier jets increased by 3.9 percent compared to 2016, an average increase of about 29 flights per day. Commercial non-jet operations (such as Cape Air and Porter Airlines) decreased by 5.9 percent, from about 129 operations per day in 2017 to 121 operations per day in 2016. Overall, commercial air carrier aircraft accounted for most of the annual increase in operations.

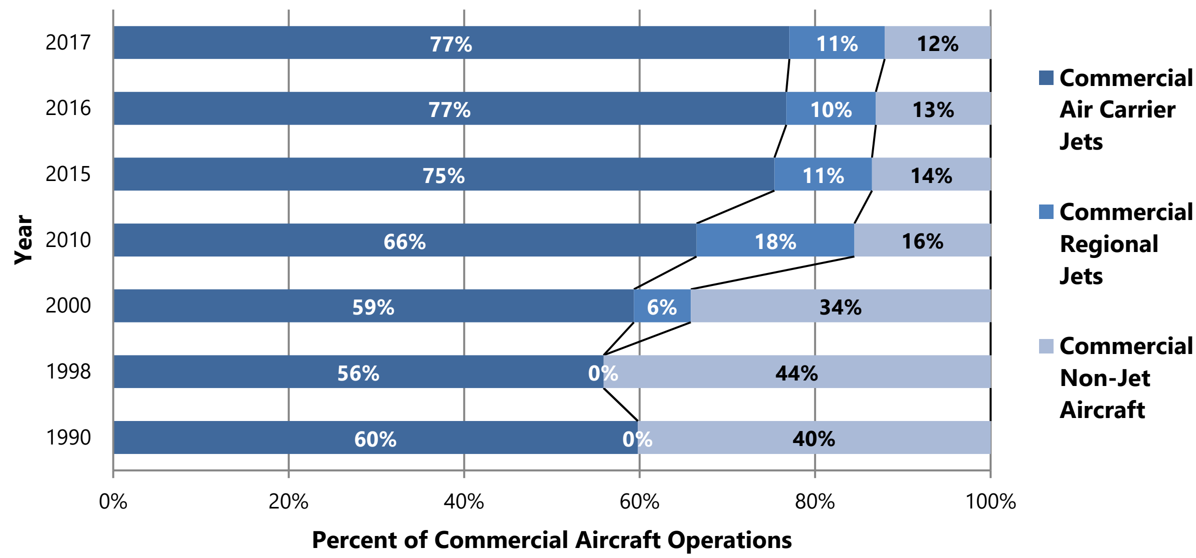
The number of operations by regional jet (RJ) aircraft, which had been decreasing in recent years, increased between 2016 and 2017 by 7.7 percent, an average increase of about eight operations per day. RJs are defined as those aircraft with 90 or fewer seats, consistent with the categorization in Chapter 2, *Activity Levels*.[9] For years prior to 2010, the RJs in EDRs and ESPRs were classified as aircraft with fewer than 100 seats. When RJs first started gaining popularity, the aircraft types available were typically 50 seats or fewer with the traditional air carrier jet being 100 seats and higher. As newer aircraft types have become available, the smaller 35- to 50-seat types have been replaced by 70- to 99-seat types, with the 90 and above seat types flying many of the traditional air carrier routes. Therefore the 90 seat and higher aircraft types are classified as air carrier.

The share of RJs in the Airport's overall commercial fleet increased to 11 percent, with RJ operations increasing to 39,478 in 2017 from 36,758 in 2016. Non-jets' share of the commercial fleet fell from 13 percent to 12 percent. The commercial air carrier operations remained at 77 percent of commercial operations for both 2016 and 2017 (with 276,469 operations in 2016 and 286,449 operations in 2017). **Figure 6-2** presents the commercial aircraft operations by category in terms of percent of the total for each year from 2015 through 2017, with 1990, 1998, 2000, and 2010 included for historical context. This figure demonstrates the decrease in commercial non-jet operations after 2000 and the rise of the RJ category. The RJ share has shown a gradual decrease through 2016 due to the trend among carriers of operating larger aircraft. A slight increase in RJ share occurred in 2017.

As shown in **Table 6-1**, the number of non-commercial operations, all categorized as GA activity, remained about the same from 2016 to 2017.

9 U.S. Code, 2006 Edition, Supplement 3, Title 49 – Transportation Subtitle VII – Aviation Programs Part A – Air Commerce and Safety, Subpart II, Economic Regulation, Chapter 417 - Operations or Carriers, Subchapter III - Regional Air Service Incentive Program, Sec. 41762 – Definitions – defines regional jet air carrier service to be aircraft with a maximum of 75 seats. Therefore, this report categorizes aircraft with 70 to 75 seats and fewer as regional jets and aircraft with 90 seats and higher aircraft as air carriers (note that there are no aircraft types with between 75 and 90 seats).

Figure 6-2 Fleet Mix of Commercial Operations (Passenger and Cargo) at Logan Airport



Source: HMMH, 2019.
Notes: Includes both passenger and cargo operations.
Since 2010, the split between air carrier jets and regional jets (RJs) is 90 seats with RJs having fewer than 90 seats.
Prior to 2010, the split between air carrier jets and RJs was 100 seats with RJs having fewer than 100 seats.
The share of RJs as a percentage of the commercial fleet was not tracked prior to 2000.

FAA Jet Aircraft Noise Categories

All jet aircraft in the U.S., including those currently operating at Logan Airport, are categorized according to their noise emission levels by the FAA as either Stage 3, Stage 4, or Stage 5. The oldest and noisiest aircraft, Stage 1, were phased out of service in the 1980s. The FAA banned Stage 2 aircraft operations in the contiguous U.S. as of December 31, 2015, and recently adopted a higher (quieter) standard of noise classification called Stage 5. Stage 5 aircraft are certificated as a cumulative 17-dB below Stage 3 standards and will be effective for new aircraft type certification after December 31, 2017 and December 31, 2020, depending on the weight of the aircraft.[10] Nearly 20 percent of the Logan Airport jet fleet already meets Stage 5 standards and that percentage will grow to over 55 percent in the Future Planning Horizon. Appendix H, *Noise Abatement*, provides more detail on the aircraft stage designations regulated by FAR Part 36 and the regulatory framework governing aircraft noise.

Examples of Stage 3, Stage 4 and Stage 5 aircraft types currently operating at Logan Airport are shown in **Table 6-2**. As shown in the table, noise levels decrease with each stage of aircraft design. The regulation provides a Stage 3 noise limit for each aircraft that is dependent on the aircraft's weight. A cumulative level, determined by summing the certification lateral, flyover, and approach values can be compared against the permissible limit. The columns on the right side of **Table 6-2** show this sum, the limit for that aircraft, and the dB difference. The Stage 5 aircraft shows the greatest difference, at over 32 dB below the limit.

10 The Stage 5 Final Rule was published on October 5, 2017. https://www.federalregister.gov/documents/2017/10/04/2017-21092/stage-5-airplane-noise-standards.

Due to noise differences among aircraft, Massport tracks operations by aircraft certification/stage. **Table 6-3** provides the percentage of commercial jet operations by stage for the past three years with 1990, 1998, 2000, and 2010 also reported for historical context. As noted in **Table 6-3**, almost 98 percent of the 2017 commercial jet fleet at Logan Airport meets at least Stage 4 requirements. About 18 percent of Logan Airport's commercial jet fleet complies with the FAA's newest noise category, Stage 5, for both 2016 and 2017. **Table H-3** in Appendix H, *Noise Abatement* provides the same data for every year since 1998.

Nighttime Operations

Massport monitors flights that operate during the DNL nighttime period of 10:00 PM to 7:00 AM, when each modeled flight is increased by 10 dB in calculations of noise exposure. **Table 6-4** shows this nighttime activity by different groups of aircraft. Commercial jet nighttime operations increased from an average 142.2 operations per night in 2016 to 158.5 operations per night in 2017 while commercial non-jet nighttime operations decreased from 3.0 in 2016 to 2.2 in 2017. GA nighttime operations increased from 6.5 in 2016 to 6.8 in 2017. These changes resulted in 15.4 additional flights per night. Nighttime operations represented 15 percent of total operations for 2017 at Logan Airport.

Overall daytime operations increased by 1.3 percent (335,723 in 2016 to 340,216 operations in 2017) while nighttime operations increased by 10.2 percent (55,499 in 2016 to 61,155 operations in 2017). **Table 6-1** and **Table 6-4** present these changes in the average daily data operations. As in years past, the majority (82 percent) of 2017 nighttime operations (between 10:00 PM and 7:00 AM) occurred either before midnight or after 5:00 AM as shown in **Figure 6-3**.

Nighttime cargo operations accounted for 5.8 percent of all commercial nighttime operations in both 2015 and 2016, and for 5.3 percent of all commercial nighttime operations in 2017. The main increases to nighttime commercial activity were in passenger aircraft operations, primarily resulting from the overall growth in domestic air carrier flights and increased flights to international destinations. The additional flights were mainly in the nighttime shoulder hours before midnight and after 5:00 AM to accommodate connecting flights and international time zones.

Table 6-2 Example Stage 3, Stage 4, and Stage 5 Aircraft Types Operating at Logan Airport

Name	Model	Noise Stage Equivalent	Cumulative Level[1]	Stage 3 Limit	dB Difference	Percent below limit
737-300	CFM56-3-B1	3	276.8	286.4	9.6	3.4%
737-700	CFM56-7B22	4	274.1	288.1	14.0	4.9%
787-8R[2]	Trent 1000-A2	5	271.2	303.2	32.0	10.6%

Source: Information provided from AEDT model defaults.
1 Cumulative levels include lateral, overflight, and approach noise.
2 The original Stage 3 noise limits are based on aircraft weight. Since the 787-8R is a larger aircraft than the Boeing 737 family, the certification levels to meet Stage 5 are higher.

Table 6-3 Percentage of Commercial Jet Operations by Part 36 Stage Category

Year[1]	Stage 5 Requirements[5]	Stage 4 Requirements[2]	Certificated Stage 3	Recertificated Stage 3[3]	Stage 2 (Greater than 75,000 lbs.)	Total
1990	N/A	N/A	51.1%	0.0%	48.9%	100%
1998	N/A	N/A	65.9%	21.7%	12.4%	100%
2000[6]	N/A	N/A	75.0%	24.0%	1.0%	100%
2010[6]	N/A	93.2%	5.7%	1.1%[4]	0.0%	100%
2015	N/A	96.7%	3.3%	0.0%	0.0%	100%
2016	17.8%	79.2%	3.0%	0.0%	0.0%	100%
2017	17.7%	79.8%	2.4%	0.0%	0.0%	100%

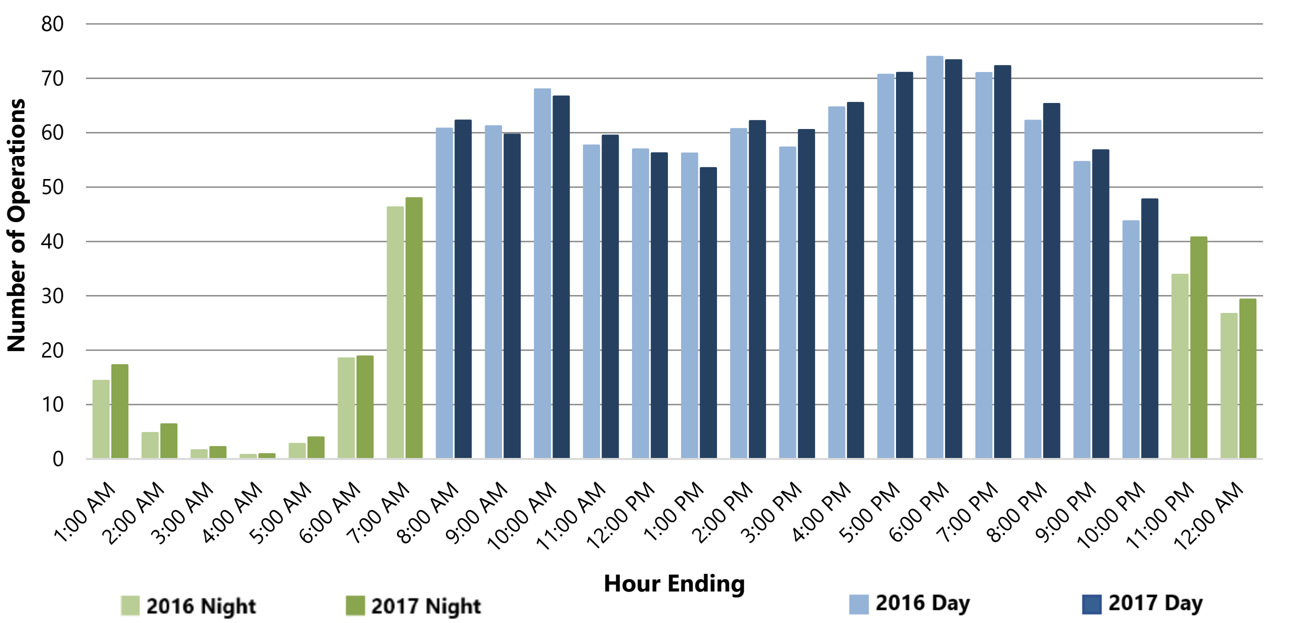
Source: Massport's Noise Monitoring System, Revenue Office and HMMH 2019.
Notes: Totals may not add exactly due to rounding.
1 Data for all years beginning in 1998 are available in Appendix H, *Noise Abatement*.
2 Aircraft that meet Stage 4 requirements are aircraft that are certificated Stage 4 or would qualify if recertificated. Certificated Stage 4 aircraft were not available until 2006 and the level of aircraft that meet Stage 4 requirements has not been determined prior to 2009.
3 Recertificated Stage 3 aircraft are aircraft originally manufactured as a certificated Stage 1 or 2 aircraft under Federal Aviation Regulation (FAR) Part 36 that either have been retrofitted with hushkits or have been re-engined to meet Stage 3 requirements.
4 Prior to 2013, only one commercial carrier, with more than 100 annual operations, continued to use recertificated Stage 3 aircraft at Logan Airport (FedEx). A few charter operators also use these aircraft.
5 Aircraft that meet Stage 5 requirements are aircraft that are certificated Stage 5 or would qualify if recertificated. Certificated Stage 5 aircraft will not be available until 2018 and the level of aircraft that meet Stage 5 requirements has not been determined prior to 2016. All aircraft listed as meeting Stage 5 requirements are originally certificated as Stage 3 or 4 aircraft.
6 Percentages for year 2000 were incorrectly reported in this table in the *2016 Environmental Data Report (EDR)*; values have been corrected here. Certificated Stage 3 percent for 2010 has also been corrected.

Table 6-4 Modeled Nighttime Operations (10:00 PM to 7:00 AM) at Logan Airport Per Night[1]

Year	Commercial Jets	Commercial Non-Jets	General Aviation	Total
1990	77.2	11.7	N/A[2]	89.0
1998	101.4	21.9	20.9[3]	144.2
2000	103.9	21.6	5.7	131.2
2010	107.9	5.2	4.0	117.1
2015	131.0	2.4	5.8	139.1
2016	142.2[4]	3.0	6.5	151.6
2017	158.5	2.2	6.8	167.6
Change (2016 to 2017)	**16.3**	**(0.8)**	**0.3**	**15.9**
Percent Change	**11.5%**	**(25.4%)**	**5.4%**	**10.5%**

Source: Massport and Harris radar data; and HMMH, 2019.
Notes: Totals may not add exactly due to rounding. Changes in ( ) represent a decrease.
1 Data for all years beginning in 1990 are available in Appendix H, *Noise Abatement*.
2 Totals prior to 1998 do not include general aviation (GA) operations.
3 Previously reported as N/A. 1998 was the first year GA operations were reported and included in the total nighttime operations.
4 This value was incorrectly reported as 142.6 in the *2016 EDR*; Total has also been corrected.

Figure 6-3 Average Hourly Operations, 2016 and 2017



Source: HMMH, 2019.

Runway Use

Logan Airport's runways are shown in Figure 6-4. Runway 15R-33L and Runway 4R-22L are Logan Airport's longest runways; each of these is just over 10,000 feet in length.

Runway use refers to the frequency with which aircraft use each of these runways during the year, as dictated or permitted by availability, wind, weather, aircraft performance, demand, and air traffic control conditions. In 2017, Runway 15R-33L was the preferred runway to use at night to reduce nearby community noise, with arrivals to Runway 33L and departures from Runway 15R (known as head-to-head procedures), thus keeping flights over Boston Harbor as much as possible (although many of these flights do fly over North Shore or South Shore communities once reaching higher altitudes).

Normally during other periods of the day, Runway 9 and 22R are used primarily for departures, and Runway 4R is used primarily for arrivals. During a portion of 2017, Runway 4R-22L was closed for reconstruction resulting in Runways 27, 15R, and 33L handling a higher level of arrivals. Typically, Runways 15R, 27, 22L, and 33L are used for both arrivals and departures.

Massport coordinated with the FAA to distribute operations during the closure including the use of temporary procedures in order to reduce delays and recommended runways during this period.

Operations on Runway 27 and Runway 22R are known as Converging Runway Operations (CRO) because the extended centerlines of these runways cross within a short distance. During periods of high demand, and when Runway 22R is in use for departing aircraft, arrivals that would typically be directed to Runway 27 are sent by FAA Air Traffic Control to arrive on Runway 22L.

Runway 14-32 is unidirectional; there are no arrivals to Runway 14 and no departures from Runway 32. Additionally, Runway 14-32 can be used only during northwest or southeast wind conditions[11] when winds are 10 knots or greater. Under certain northwest wind conditions, Runway 32 provides FAA with a second arrival runway, thereby reducing delays at the Airport. Runway 14 is available for departures but is rarely used in that manner.

Runway 15L-33R is Logan Airport's shortest runway at under 3,000 feet long. This runway is primarily used for small non-jet aircraft arrivals.

11 The Runway 14-32 restrictions are a condition of the Logan Airside Improvements Project Record of Decision (ROD).

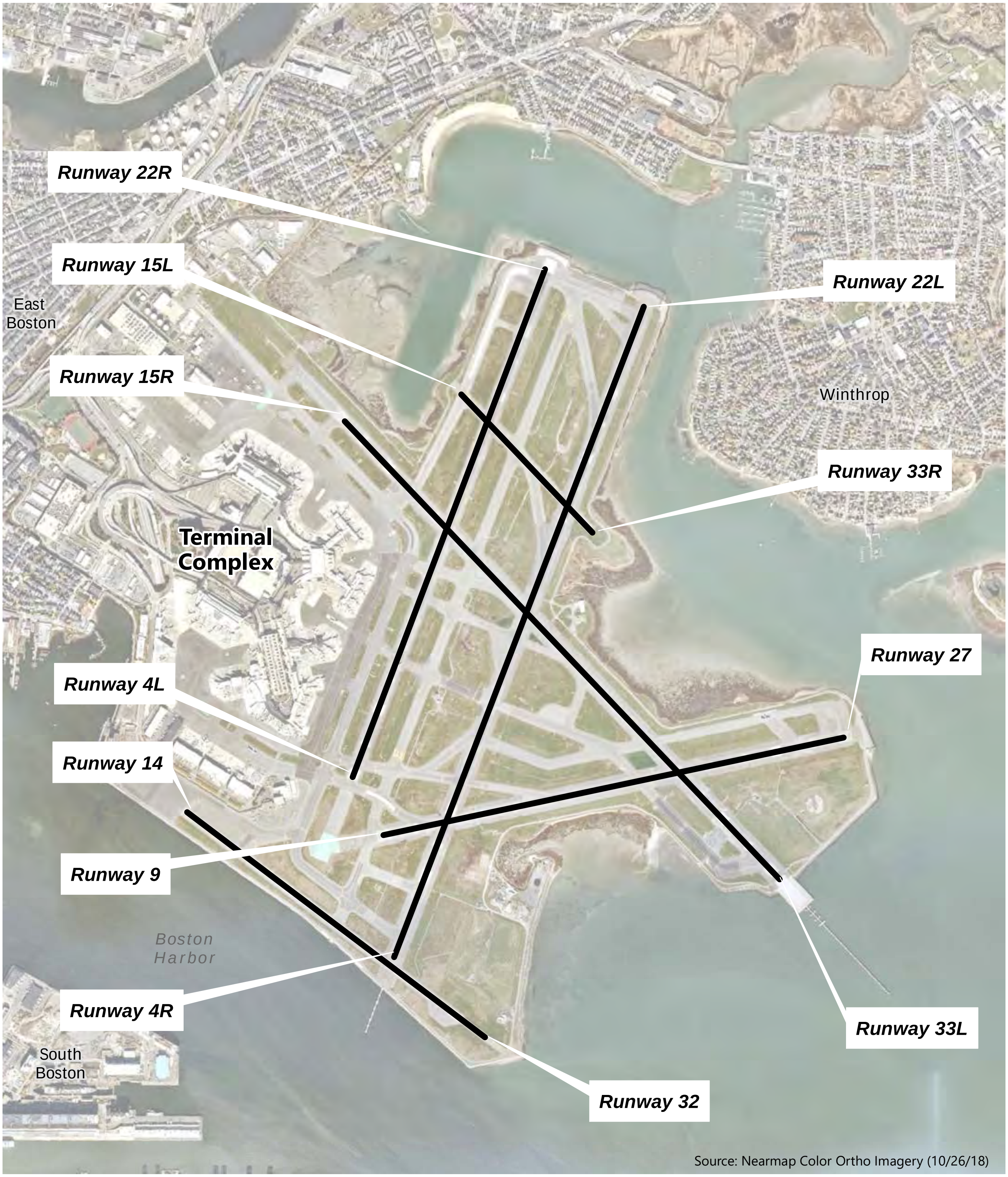


FIGURE 6-4 Logan Airport Runways

2017 Environmental Status and Planning Report

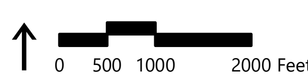


Table 6-5 provides a summary of jet runway use conditions in 2017, with recent years and historical years provided for comparison. Jet runway use in 2017 had the following notable characteristics:

- Runway 4R-22L was closed from May 15 to June 23 (35 days), with limited availability for Runway 4R arrivals through September 15th. This closure had the largest effect on arrivals and a smaller effect on departures in 2017, increasing use of other runways for those operations. In 2016, a shorter duration closure of Runway 4L-22R (31 days) occurred.
- For arrivals, Runway 4R, which accommodated 29 percent and 31 percent of aircraft arrivals in 2015 and 2016, respectively, experienced the most substantial change with a reduction to 21 percent in 2017. Arrivals to Runway 4L increased slightly and arrivals to Runway 22L decreased slightly. The extended closure of Runway 4R-22L resulted in a shift in arrival usage to the other runways, increasing generally in proportion to their usual usage rates; Runway 27 absorbed more of the shifted arrivals than Runway 33L or Runway 32. Runway 15R had a significant increase in arrivals, from 2 percent and 1 percent in 2015 and 2016 (respectively) to 5 percent of arrivals in 2017.
- For departures, use of Runway 4R departures declined from 4 percent in 2016 to 2 percent in 2017 due to the extended closure. Likewise, Runway 22L departures declined from 2 percent in 2016 to 1 percent. Usage of Runway 33L for departures increased the most, from 15 percent and 18 percent in 2015 and 2016, respectively, to 23 percent of departures in 2017. Departures from Runway 27 also increased, but to a lesser extent, and departures from Runway 9 decreased from 29 percent and 30 percent in 2015 and 2016, respectively, to 25 percent of departures in 2017.

Detailed runway use for all aircraft types (Jet and Non-Jet) for 2016 and 2017 is provided in Appendix H, *Noise Abatement*.

Table 6-5 Summary of Annual Jet Aircraft Runway Use[1]

	Runway									
	4L	**4R**	**9**	**14[2]**	**15R**	**22L**	**22R**	**27**	**32[2]**	**33L**
1990										
Departures	0%	3%	21%	N/A	10%	2%	36%	20%	N/A	7%
Arrivals	1%	25%	0%	N/A	2%	14%	0%	28%	N/A	29%
1998										
Departures	0%	8%	35%	N/A	6%	5%	28%	14%	N/A	5%
Arrivals	2%	41%	0%	N/A	2%	7%	0%	28%	N/A	19%
2000										
Departures	0%	8%	35%	N/A	4%	3%	30%	15%	N/A	6%
Arrivals	4%	40%	0%	N/A	1%	7%	0%	28%	N/A	20%
2010										
Departures	0%	4%	28%	<1%	8%	2%	31%	10%	0%	17%
Arrivals	5%	28%	0%	0%	1%	15%	0%	32%	1%	16%
2015										
Departures	0%	4%	29%	<1%	5%	2%	32%	12%	0%	15%
Arrivals	5%	29%	0%	0%	2%	25%	<1%	23%	1%	16%
2016										
Departures	0%	4%	30%	0%	6%	2%	27%	13%	0%	18%
Arrivals	4%	31%	0%	0%	1%	24%	<1%	23%	1%	16%
2017										
Departures	0%	2%	25%	0%	5%	1%	28%	15%	0%	23%
Arrivals	5%	21%	0%	0%	5%	23%	<1%	27%	2%	18%

Source: Massport Noise Office and HMMH, 2019.

Notes: These data reflect actual percentages of jet aircraft operations on each runway end. They should not be confused with effective runway use.
Jet aircraft are not able to use Runway 15L or 33R due to its length of only 2,557 feet.
Totals may not add exactly due to rounding.

N/A Not available.

1 Data for all years beginning in 1990 are available in Appendix H, *Noise Abatement*.

2 Runway 14-32 opened in late November 2006. Runway 14-32 is unidirectional with no arrivals to Runway 14 and no departures from Runway 32.

Preferential Runway Advisory System (PRAS)

To provide an equitable distribution of Logan Airport's noise impacts on surrounding communities, in 1982 Massport developed the Preferential Runway Advisory System (PRAS). The system was enhanced in 1990 and in subsequent years. The two primary objectives of PRAS are to equitably distribute noise on an annual basis and to provide short-term relief from continuous operations over the same neighborhoods at the ends of the runways.

PRAS consisted of two parts: (1) a set of specific runway use goals to address the PRAS objectives, and (2) a computer program that would provide runway configuration recommendations to air traffic controllers based on weather, traffic, and PRAS goals. In February 2004, the PRAS system was suspended due to an upgrade of the FAA radar system during the consolidation of the Boston Terminal Control Center at the new facility in Merrimack, New Hampshire, and has not since restarted.

During Phase 2 of the recently concluded Boston Logan Airport Noise Study (BLANS), the Logan Airport Community Advisory Committee (CAC) voted to abandon PRAS because it had not achieved the intended noise abatement.[12] Phase 3 of the BLANS focused on the development of an updated Runway Use Program. Operational tests of a new program began in November 2014 and continued through September 2016. The BLANS project ended in 2016 without the Logan Airport CAC agreeing on a new Runway Use Program. A final BLANS project report was issued in April 2017.

Although the PRAS was discontinued, the PRAS goals remain a benchmark to assess the equity of noise impacts, and Massport continues to present an assessment of runway use data relevant to the PRAS goals. Under the PRAS, each runway end has a specific annual utilization goal, defined separately for departures and arrivals. The goals are defined in terms of effective usage, which applies a factor of 10 to nighttime (10:00 PM to 7:00 AM) operations, equivalent to increasing nighttime exposure by 10 dB so that a change in effective utilization is roughly proportional to the change in DNL.

Table 6-6 provides a comparison of effective runway use[13] in 2017 to that of 2016 and 2015, and to the PRAS goals. The 2017 utilizations shown in bold indicate improvements toward the goals for each runway compared to 2016. All of the arrival percentages moved closer to the PRAS goals in 2017 (compared to 2016) and two of the departure percentages moved toward the PRAS goals.

12 BLANS Level 3 Screening Analysis, FAA, December 2012, Page E-2.

13 Effective Runway use refers to runway use which applies a factor of 10 to the night operations, similar to DNL.

Table 6-6 Effective Jet Aircraft Runway Use in Comparison to Preferential Runway Advisory System (PRAS) Goals

	PRAS Effective Usage Goals		2015 Effective Usage		2016 Effective Usage		2017 Effective Usage	
Runway End	**Arrivals**	**Departures**	**Arrivals**	**Departures**	**Arrivals**	**Departures**	**Arrivals**	**Departures**
4R/L	21.1%	5.6%	25.1%	4.1%	26.4%	3.8%	**18.2%**	1.7%
9	0.0%	13.3%	0.0%	22.3%	0.0%	23.9%	0.0%	**19.2%**
15R	8.4%	23.3%	1.9%	13.1%	0.7%	12.6%	**3.7%**	11.0%
22L/R	6.5%	28.0%	31.3%	30.8%	28.0%	26.4%	**24.3%**	24.7%
27	21.7%	17.9%	16.6%	14.6%	20.4%	16.2%	25.9%	20.3%
33L	42.3%	11.9%	24.5%	15.1%	24.0%	17.0%	**27.1%**	23.0%
14[1]	N/A	N/A	0.0%	<0.1%	0.0%	0.0%	0.0%	0.0%
32[1]	N/A	N/A	0.5%	0.0%	0.6%	0.0%	0.7%	0.0%

Source: Massport Noise Office and HMMH, 2018.
Notes: PRAS goals are stated in terms of effective jet operations which exclude non-jet flights, but which multiply each nighttime (10:00 PM to 7:00 AM) operation by a factor of 10.
Bold text indicates runway use that is closer to PRAS goals from the prior year.
N/A Not available.
1 Runway 14-32 opened following the suspension of PRAS; consequently, PRAS goals were not established for this runway.

Flight Tracks

As described in the *Noise Modeling Process* section of this chapter, Massport uses a data pre-processor known as RC for AEDT™. Appendix H, *Noise Abatement,* provides more information about this software package. Instead of using representative model tracks, RC for AEDT™ converts each radar track to an AEDT model track and then models the scaled operation on that track.[14] This allows Massport to account for runway closures and/or temporary or permanent airspace changes that occur during the year, events which would be much more difficult to accurately capture with conventional modeling methods.

For this *2017 ESPR*, 394,548 flight tracks were modeled to calculate the noise levels surrounding Logan Airport for calendar year 2017. **Figures 6-5** through **6-11** provide examples of flight tracks used with RC for AEDT™ to develop the 2017 contours.[15] The figures show arrivals and departures throughout the year from a representative sample for each of three aircraft categories: air carrier jets, RJs, and non-jets. By 2011, implementation of RNAV departure and arrival procedures from the BLANS was completed. In addition to the RNAV procedures recommended from the BLANS study, other RNAV procedures implemented at Logan Airport (such as the RNAV arrivals into the terminal airspace) are part of a national FAA initiative, which is being

14 This method provides a one to-one correspondence of radar tracks to model tracks and ensures that the lateral and vertical dispersion of aircraft types are consistent with the radar data.

15 The flight tracks shown in these figures are a representative sample, selected uniformly from the complete track set to match the overall annual runway use.

implemented to improve safety and efficiency in the airspace system. These procedures result in consolidated flight paths and greater predictability along the flight route. Similar procedures have been implemented at Denver, Minneapolis, Baltimore-Washington, Houston, Dallas, Chicago Midway, Phoenix, and Seattle Airports.

- **Figure 6-5** displays air carrier jet departures following the FAA RNAV departure procedures.
- **Figure 6-6** displays air carrier jet arrivals. The RNAV arrival procedures are very evident in the 2017 modeled data with a narrowing of the flight tracks into concentrated areas.
- **Figure 6-7** displays the RJ departures following the RNAV departure routes in the same manner as the larger air carrier jets.
- **Figure 6-8** displays the RJ arrivals, again resembling the patterns of the larger air carrier jets.
- **Figure 6-9** displays the non-jet departures that tend to turn early off the runways and do not follow the jet departure routes. Non-jet departures from Runways 4L, 22R, 33L, and 27 are allowed to turn over populated areas whereas the jet aircraft are not. This also keeps the non-jet aircraft out of the jet departure paths allowing for efficient jet departures.
- **Figure 6-10** displays the non-jet arrivals and includes the Boston Harbor route for non-jet aircraft arriving to Runway 4L. The graphic also displays the non-jet arrivals to Runways 22R and 33R in addition to the other runways, which also accommodate jets.
- **Figure 6-11** displays the night jet arrivals using the Light Visual Approach[16] to Runway 33L. This is a procedure developed from the BLANS project, which is available only during visual conditions at night in which pilots can follow a route offshore to reduce noise impacts. These flights remain offshore and avoid overflying Cohasset and Hull at night. Flights arriving to Runway 33L from the west pass over Saugus and Nahant at a higher altitude and then head south over Boston Harbor to intersect with the visual approach procedure. Of 10,368 nighttime arrivals to Runway 33L in 2017, approximately 1,000 used this procedure. An RNAV visual approach procedure[17] developed by jetBlue Airways coincides with the route of the standard visual approach. This procedure gives aircraft with advanced navigational capabilities a more stabilized approach to the visual Runway 33L. This procedure is now available to authorized airlines only and is seen in the concentrated approach path in **Figure 6-11**.

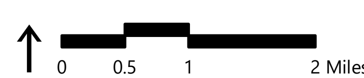
Meteorological Data

AEDT has several settings that reflect aircraft performance profiles and sound propagation based on meteorological data. Meteorological settings include average temperature, dew point, barometric pressure, and relative humidity at the Airport. FAA requires using the multiyear average data provided with the AEDT model. However, since the noise results represent an individual year, Massport obtained approval from FAA to use data for that specific year (see Appendix H, *Noise Abatement)*. Massport obtained weather data for 2017 from the National Climatic Data Center and used an annual average in modeling all 2017 operations.

16 A Visual Approach procedure can only be used when weather conditions permit and the pilots follow visual landmarks to follow the procedure.

17 Boston Logan Runway 33 Left Area Navigation (RNAV) Visual Flight Procedure Test CATEX, approved June 26, 2013.

FIGURE 6-5 Air Carrier Departure Flight Tracks



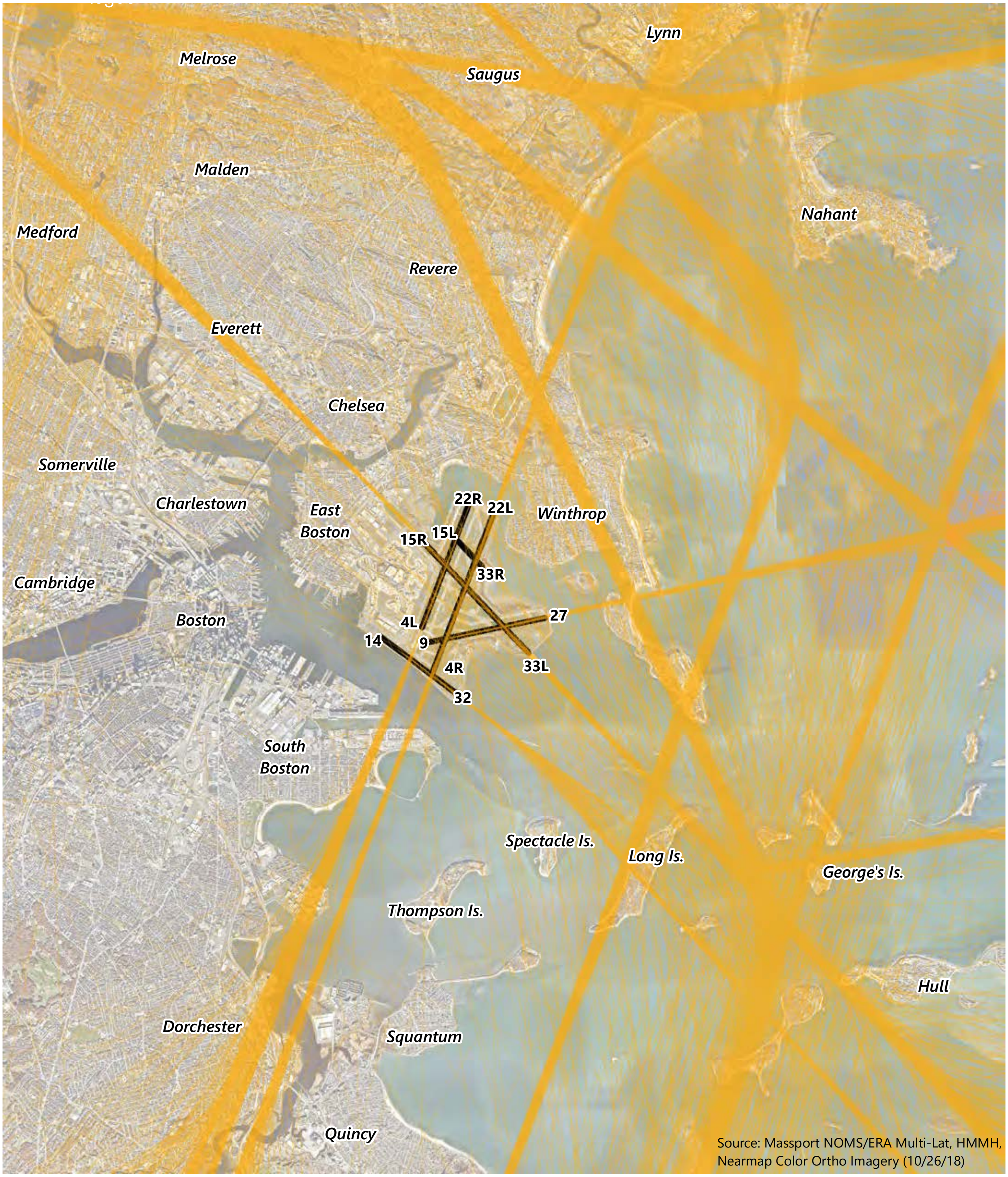


FIGURE 6-6 Air Carrier Arrival Flight Tracks

2017 Environmental Status and Planning Report

FIGURE 6-7 Regional Jet Departure Flight Tracks

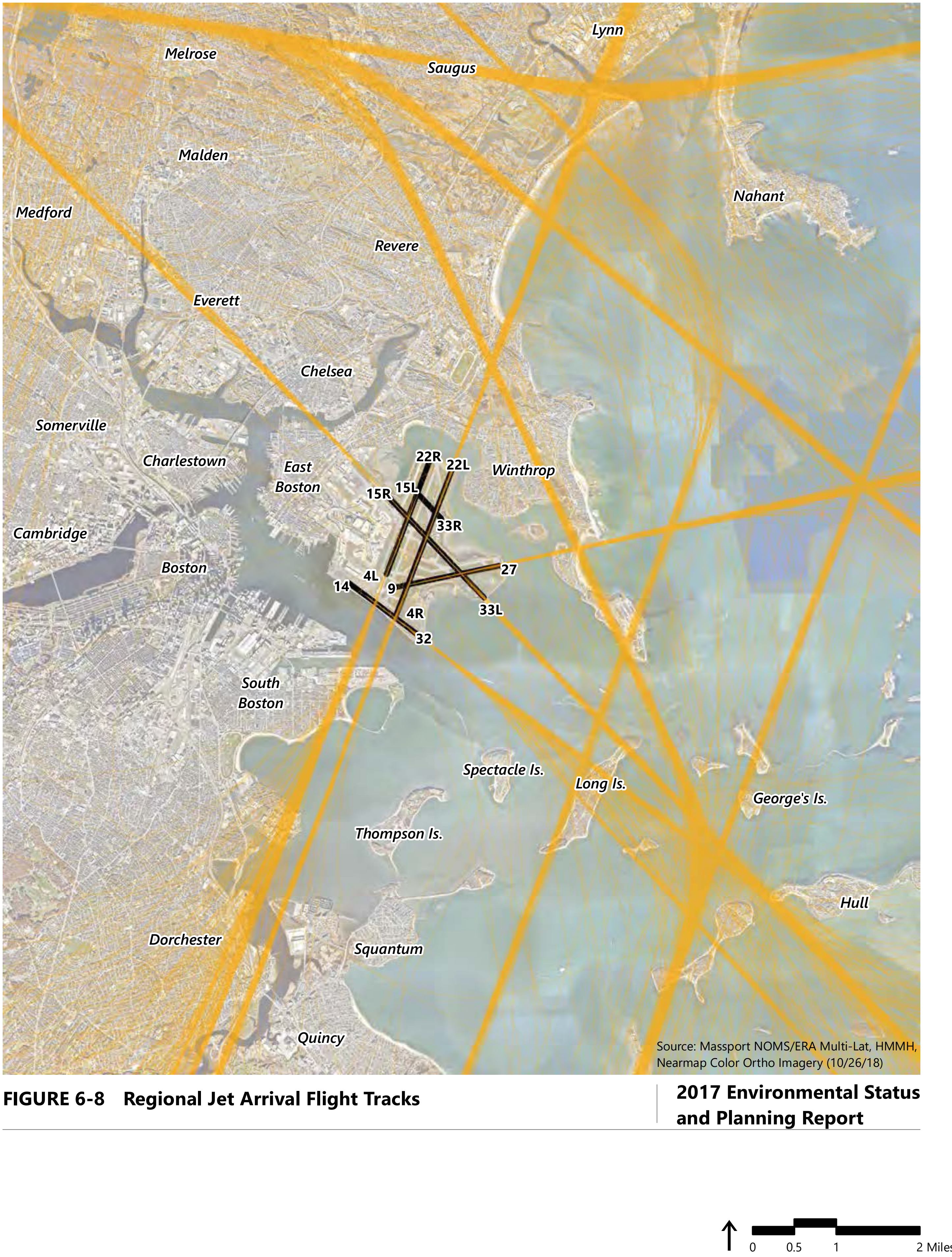


FIGURE 6-8 Regional Jet Arrival Flight Tracks

2017 Environmental Status and Planning Report

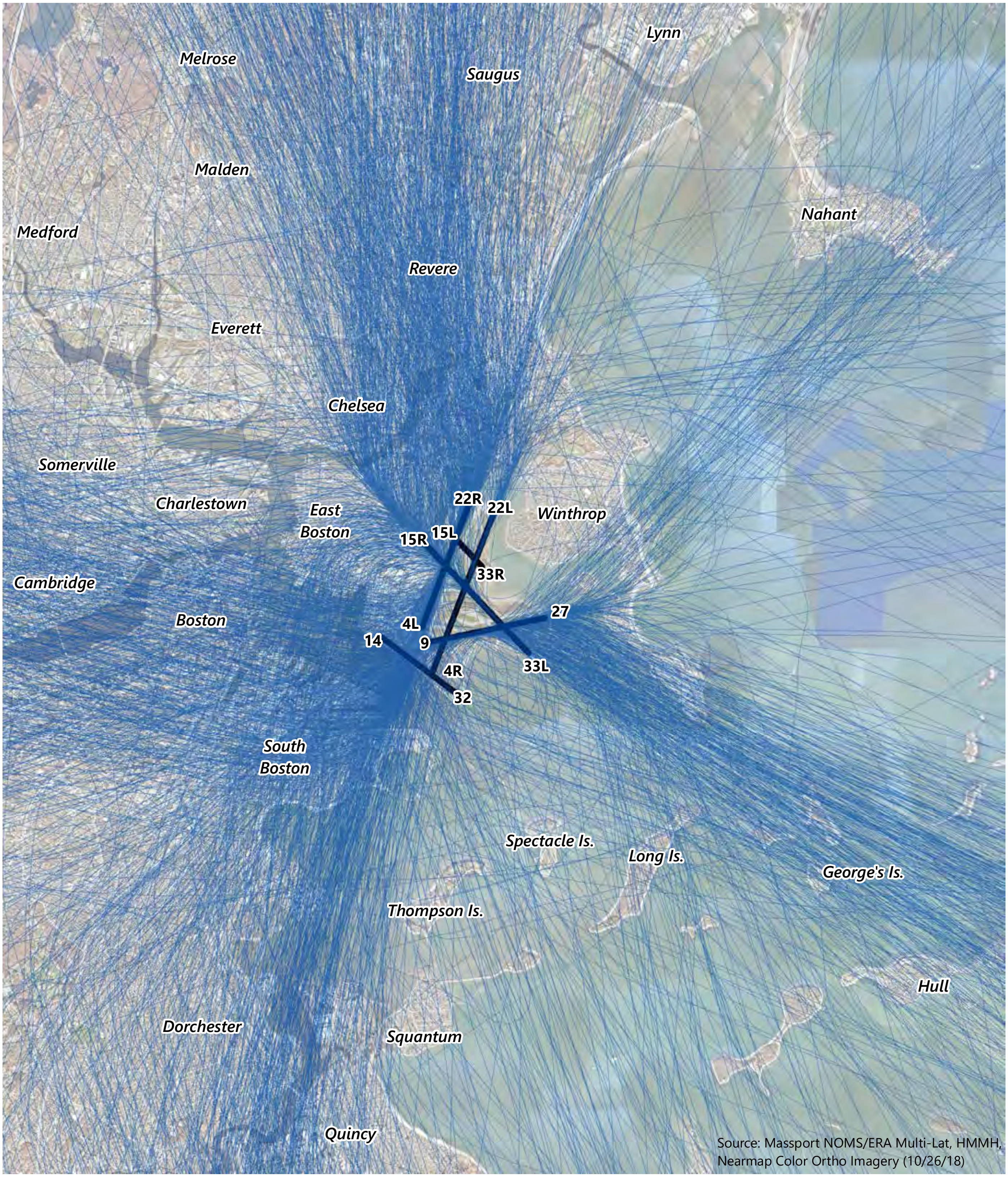


FIGURE 6-9 Non-Jet Departure Flight Tracks

2017 Environmental Status and Planning Report

Note: Non-jet tracks are non-RNAV.

0 0.5 1 2 Miles

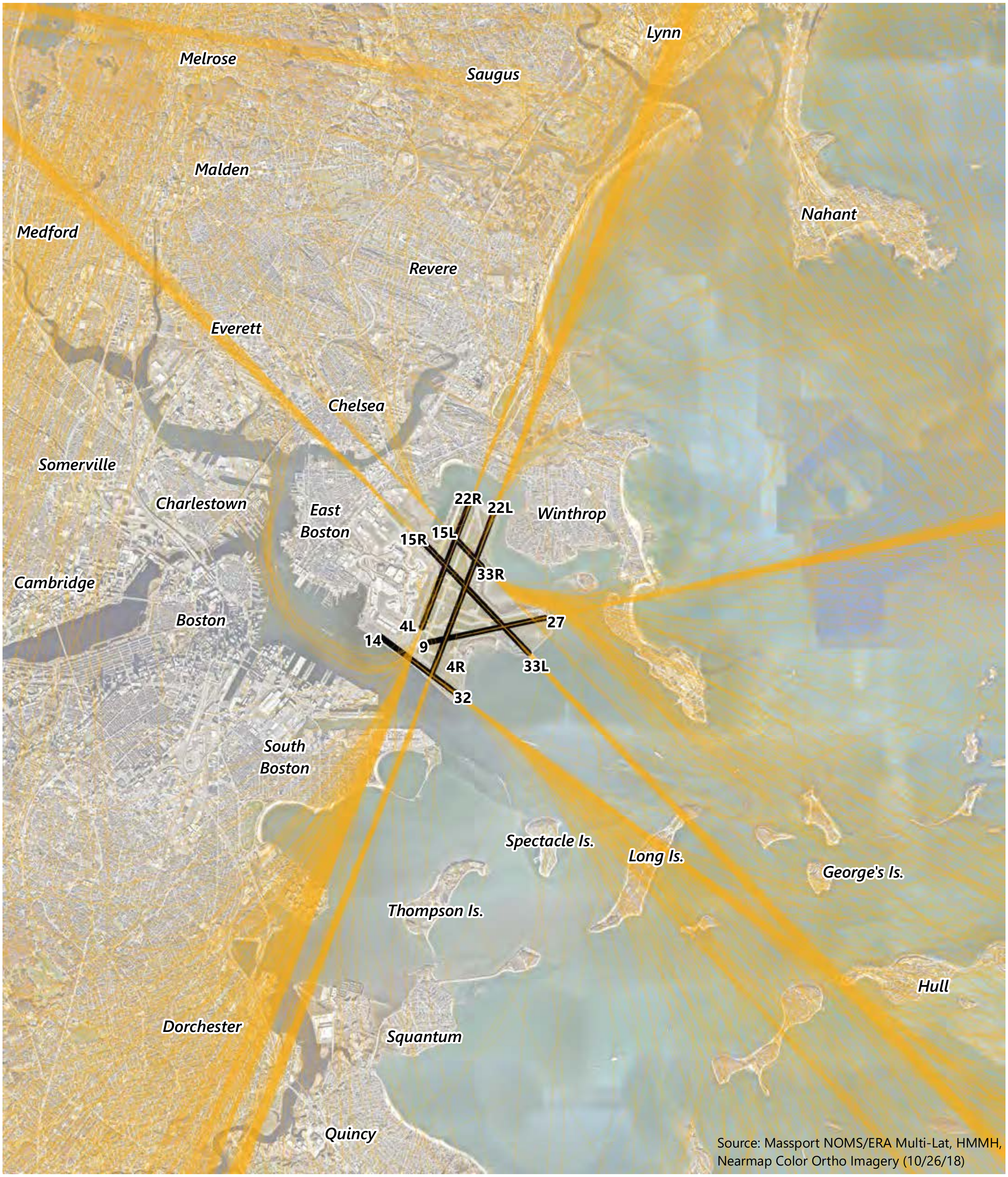


FIGURE 6-10 Non-Jet Arrival Flight Tracks

2017 Environmental Status and Planning Report

Note: Non-jet tracks are non-RNAV.

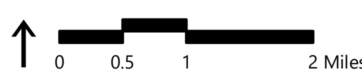


FIGURE 6-11 **Runway 33L Night (10PM - 7AM) Light Visual Approach Arrival Flight Tracks**

2017 Environmental Status and Planning Report

Noise Levels in 2017

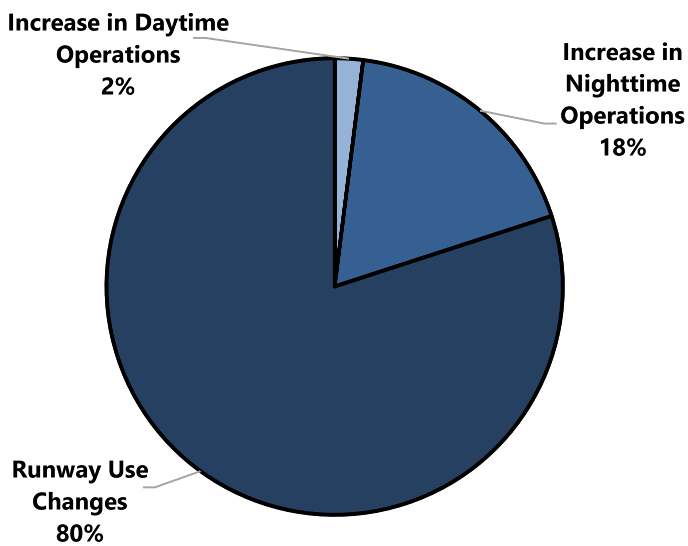
The following section describes the results of noise modeling in AEDT for 2017. The DNL contours are presented graphically, the population living within contour intervals are tabulated, and DNL values computed by the model for the specific noise monitor locations are compared to the measured noise levels. Historical data are also provided for context. DNL 65 dB is the focus of much of the noise analysis, as it is the threshold for noise incompatibility with residential land use,[18,19] for both FAA and the U.S. Department of Housing and Urban Development.

Day-Night Noise Contours for 2017

The 2017 DNL contours were prepared using the most recent version of FAA's AEDT model, version 2d. Massport transitioned to the AEDT model from the INM in its *2016 EDR*. That document provides detailed analyses of the differences in the models and the resultant DNL contours for Logan Airport. This ESPR compares the 2017 DNL contours to the 2016 DNL contours developed in AEDT.[20]

Compared to 2016, aircraft operations at Logan Airport in 2017 were different in overall volume, proportion of nighttime operations, and runway use. **Figure 6-12** shows the relative influence of these factors on changes in the noise contour.

Figure 6-12 Reason for Changes in Number of People Exposed to Day-Night Average Sound Level (DNL) Values Greater than or Equal to 65 dB (2016 to 2017)



Source: HMMH, 2019.

18 14 Code of Federal Regulations Part 150, Appendix A to Part 150 Noise Exposure Maps, Sec. A150.101(d)).

19 24 Code of Federal Regulations Part 51, Subpart B Noise Abatement and Control, Sec. 51.103(c)).

20 The 2016 Day-Night Average Sound Level (DNL) contours were developed in Aviation Environmental Design Tool (AEDT) 2C SP2 and the 2017 DNL contours were developed with AEDT 2d. The AEDT 2d upgrade included three new aircraft types (in limited use at Logan Airport), emission data updates and bug fixes.

Figure 6-13 shows DNL 65 dB contours for 2016 and 2017, both modeled with the AEDT software. The DNL 65 dB contour for 1990, modeled with the INM software, is included for comparative purposes. The overall shape of the 2017 contours is very similar to 2016 conditions, with any differences attributable to the types of aircraft operations that occurred in a given area and the proportion of nighttime operations.

The overall increase in the size of the contour reflects the 2.6-percent increase in operations from 2016 to 2017. As noted in the discussion of **Tables 6-1** and **6-4**, overall daytime operations in 2017 increased by 1.3 percent from 2016, while nighttime operations increased by 10.2 percent. Because of the 10-dB weighting assigned to nighttime operations in the calculation of DNL, nighttime changes have a more pronounced effect on the DNL contours than daytime changes.

The other main factors influencing the 2017 noise contours are the shifts in effective runway use (summarized in **Table 6-6**). As noted previously in this chapter in the discussion of runway use, Runway 4R-22L was closed for a 35-day period in May and June 2017 and then had limited availability for Runway 4R arrivals into September 2017. This closure was a major factor in the observed runway use shifts which drive the shape of the DNL contours. The closure also resulted in a slight increase in nighttime operations during that period. The expansion of the DNL 65 dB contour to the east has taken place over the water, and to the west, expansion occurred over East Boston and Chelsea. However, directly south of the airport, the 2017 DNL 65 dB contour is smaller than that for 2016.

Beginning on the west side of the airport, and moving clockwise, the contour changes are as follows:

- The lobe extending northwest beyond the Runway 15R end is longer and generally wider due to increased Runway 15R arrivals and increased Runway 33L departures;
- To the north near the Runway 22L end, the contour is narrower due to the decreases in both arrivals to Runway 22L and departures from Runway 4R;
- The lobe extending eastward beyond the Runway 27 end is longer due to increased Runway 27 arrivals and slightly narrower due to decreased Runway 9 departures;
- On the east side of the airport, the areas on either side of the eastern lobe show small increases due to start-of-takeoff-roll noise from Runway 33L;
- The lobe extending southeast beyond the Runway 33L end is longer due to increased Runway 33L arrivals and slightly narrower due to decreased Runway 15R departures; and
- The lobe extending south beyond the Runway 4R end is both shorter and narrower due to fewer Runway 4R arrivals and a decrease in Runway 22L departures.

As noted previously, the runway use shifts and consequential changes in the DNL contour shape are largely attributable to the period of Runway 4R/22L closure in 2017 for reconstruction.

FIGURE 6-13 Comparison between 1990, 2016, and 2017 DNL 65 dB Contours

2017 Environmental Status and Planning Report

2017 DNL Contour (AEDT 2d)
2016 DNL Contour (AEDT 2c)
1990 DNL Contour (INM)
Sound Insulation Areas

0 1750 3500 7000 Feet

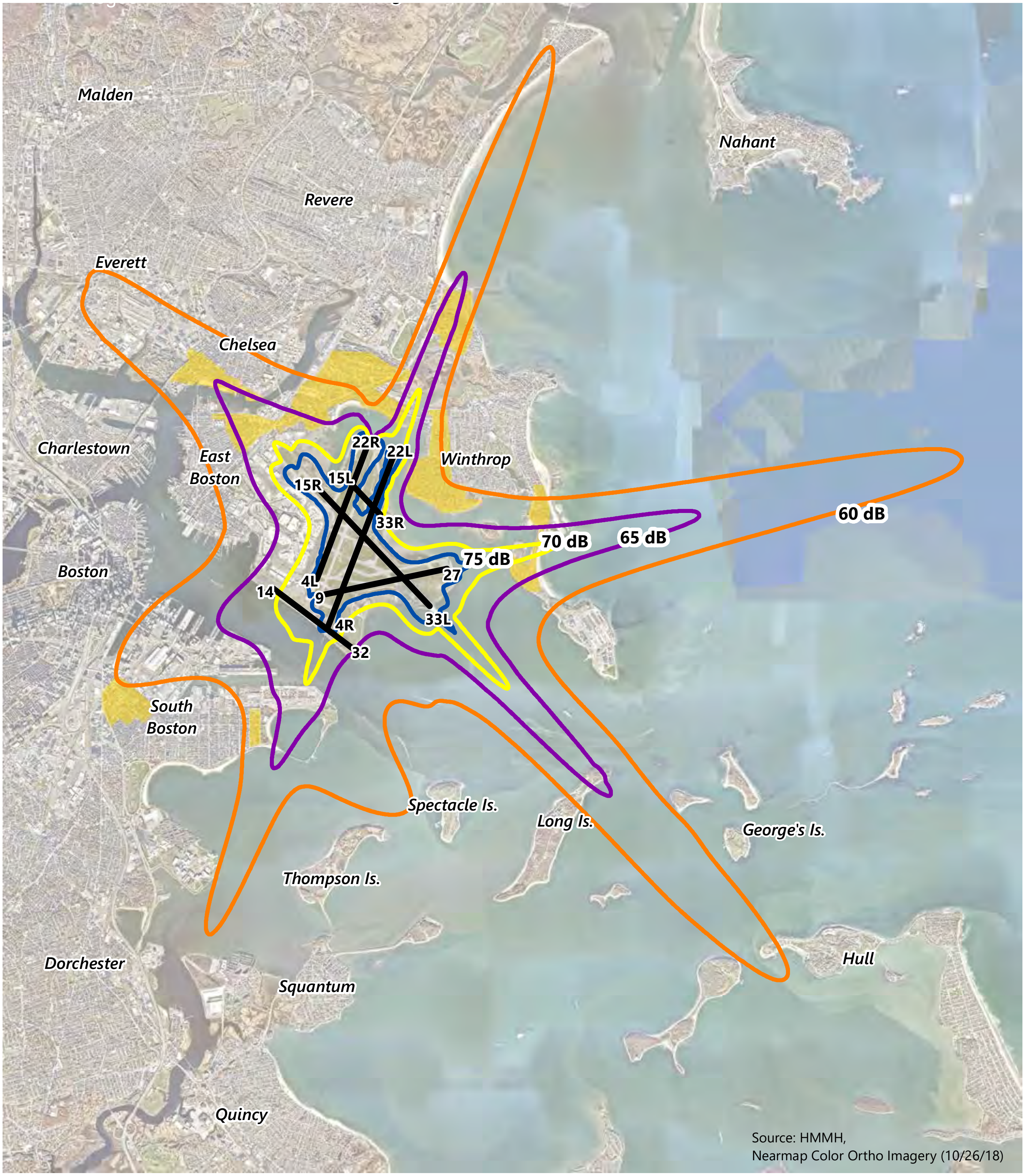


FIGURE 6-14 60-75 DNL Contours for 2017 Operations Using AEDT 2d

2017 Environmental Status and Planning Report

2017 DNL Contour (AEDT 2d)

60 dB
65 dB
70 dB
75 dB
Massport Sound Insulation Areas

0 1750 3500 7000 Feet

Population Impact Assessment

Figure 6-14 displays the complete DNL contour set for 2017. Massport reports population counts within selected 5 dB increments of exposure each year to indicate how Logan Airport's noise environment changes over time. **Table 6-7** shows population counts for 2017 by community, compared to previous years. The 2010 U.S. Census data form the basis of the population counts for 2010 and later. Population counts from 2000 through 2009 are based on U.S. Census data for 2000.

To more accurately identify population impacts, the method for calculating population impact has been updated in this *2017 ESPR*. Historically, the population calculations were developed by the noise model (AEDT or INM). The noise model determined population within a DNL contour by adding the populations of U.S. Census blocks within that contour. A block was considered to be within the contour if the center location (or centroid) was within the DNL contour.

In recent years, this method was adapted to GIS software. The DNL contours and U.S. Census block centroids and population data were imported into GIS, which then applied the same counting methodology as INM, (i.e., if a block centroid was within the contour, the population of that block was included in the count). The weakness of that method arises from the fact that the population of a U.S. Census block is distributed throughout the block, not clustered at its centroid. Blocks on the edge of the contour were either entirely included or entirely excluded from the count, but in reality, some fraction of the block's population resides within the contour.

The updated method determines the fraction of the area of the U.S. Census block that is within the contour and multiplies the block population by this fraction to determine the noise-exposed population for that block. This more accurately represents the included population within U.S. Census blocks that are on the DNL contour boundary. This proportional method, while still an approximation, also better addresses the more obscure problem of oddly-shaped blocks whose centroid is outside the block boundary.

As **Table 6-7** shows, the total number of people counted from 2010 U.S. Census data as residing within the DNL 65 dB contour increased from 7,450 in 2016 to 7,933 in 2017. These numbers are both derived from contours produced by the AEDT model and represent an estimated increase of 483 people, 6.5 percent more. The additional population is mainly from Chelsea and the area of East Boston between the Runway 15R and Runway 22R ends. These areas are affected by overflights from Runway 33L departures, which increased substantially in 2017, and arrivals to Runway 15R, which also increased in 2017.

Table 6-8 provides an additional breakdown of the estimated population in East Boston and South Boston residing within the DNL 65 dB contour and compares the 2017 totals by town to the 2016 results.

Table 6-7 Noise-Exposed Population by Community[1]

Year	> 75 DNL	70-75 DNL	65[3]-70 DNL	Total (65+)[3] DNL	Year	> 75 DNL	70-75 DNL	65[3]-70 DNL	Total (65+)[3] DNL
Boston					**Revere**				
1990	0	1,778	28,970	30,748	1990	0	0	4,274	4,274
2000	0	234	9,014[2]	9,248[2]	2000	0	0	2,496	2,496
2010	0	0	689[2]	689[2]	2010	0	0	2,413	2,413
2011	0	0	331[2]	331[2]	2011	0	0	2,547	2,547
2012	0	0	421[2]	421[2]	2012	0	0	2,762	2,762
2013	0	0	612[2]	612[2]	2013	0	0	2,505	2,505
2014	0	34	4,151[2]	4,185[2]	2014	0	0	2,832	2,832
2015	0	110	7,255[2]	7,365[2]	2015	0	0	3,789	3,789
2016	0	0	4,031	4,031	2016	0	0	2,376	2,376
2017	0	14	4,720	4,734	2017	0	0	2,362	2,362
Chelsea					**Winthrop**				
1990	0	0	4,813	4,813	1990	676	1,211	2,420	4,307
2000	0	0	0	0	2000	247	1,070	4,684	6,001
2010	0	0	0	0	2010	0	130	598	728
2011	0	0	0	0	2011	0	130	939	1,069
2012	0	0	0	0	2012	0	200	1,186	1,386
2013	0	0	0	0	2013	0	130	1,060	1,190
2014	0	0	0	0	2014	0	130	1,775	1,905
2015	0	0	0	0	2015	0	320	2,623	2,943
2016	0	0	0	0	2016	0	130	913	1,043
2017	0	0	65	65	2017	0	125	647	772
Everett					**All Communities**				
1990	0	0	0	0	1990	676	2,989	40,477	44,142
2000	0	0	0	0	2000	247	1,304	16,194	17,745
2010	0	0	0	0	2010	0	130	3,700	3,830
2011	0	0	0	0	2011	0	130	3,817	3,947
2012	0	0	0	0	2012	0	200	4,369	4,569
2013	0	0	0	0	2013	0	130	4,177	4,307
2014	0	0	0	0	2014	0	164	8,758	8,922
2015	0	0	0	0	2015	0	430	13,667	14,097
2016	0	0	0	0	2016	0	130	7,320	7,450
2017	0	0	0	0	2017	0	139	7,794	7,933

Source: Massport and HMMH, 2019.

Notes: Population counts for 2010 and later use the 2010 U.S. Census block data; Counts for 2000 used the 2000 U.S. Census data; Counts for 1990 used the 1980 U.S. Census data.

1 2017 noise analysis uses AEDT version 2d, 2016 used AEDT version 2cSP2, 2012 through 2015 used INM version 7.0d, 2011 used INM version 7.0c, 2010 used INM version 7.0b, 1990 and 2000 used earlier versions of INM. Data for years not shown here are available in Appendix H, *Noise Abatement*.

2 These values reflect the effect of the FAA-approved terrain adjustment in Orient Heights.

3 Day-Night Average Sound Level (DNL) 65 decibel (dB) is the federally-defined noise criterion used as a guideline to identify when residential land use is considered incompatible with aircraft noise.

Table 6-8 Estimated Population within DNL 65 dB[1] Contour[2]

Year	Census data	Boston East Boston	Boston South Boston	Boston Total	Chelsea	Revere	Winthrop	Everett	Total
1990	1980	N/A	N/A	30,748	4,813	4,274	4,307	0	44,142
2000	2000	8,979[3]	269	9,248[3]	0	2,496	6,001	0	17,745
2010 (INMv7.0b)	2010	689[3]	0	689[3]	0	2,413	728	0	3,830
2011 (INMv7.0c)	2010	331[3]	0	331[3]	0	2,574	1,069	0	3,947
2012 (INMv7.0d)	2010	421[3]	0	421[3]	0	2,762	1,386	0	4,569
2013 (INMv7.0d)	2010	612[3]	0	612[3]	0	2,505	1,190	0	4,307
2014 (INMv7.0d)	2010	4,185[3]	0	4,185[3]	0	2,832	1,905	0	8,922
2015 (INMv7.0d)	2010	7,365[3]	0	7,365[3]	0	3,789	2,943	0	14,097
2016 (AEDT 2c)	2010	4,031	0	4,031	0	2,376	1,043	0	7,450
2017 (AEDT2d)	2010	4,734	0	4,734	65	2,362	772	0	7,933
Change from 2016 to 2017		**703**	**0**	**703**	**65**	**(14)**	**(271)**	**0**	**483**

Source: Massport and HMMH, 2018.
Notes: Population counts for 2000 are based on the 2000 U.S. Census block data and for 1990 from the 1980 U.S. Census block data. Population counts for 2010 through 2017 are provided for the 2010 U.S. Census block data (as indicated). Changes in ( ) represent a decrease in estimated population.
N/A Not available.
1 Day-Night Average Sound Level (DNL) 65 decibel (dB) is the federally-defined noise criterion used as a guideline to identify where residential land use is considered incompatible with aircraft noise.
2 Data for years prior to 2010 are available in Appendix H, *Noise Abatement*.
3 These values reflect the effect of the FAA-approved terrain adjustment in Orient Heights.

The assessment of noise-exposed populations varies depending on the model used. As discussed in the *2016 EDR*, AEDT-modeled contours are smaller than INM-modeled contours, which included FAA-approved over-water effects, hill effects, and custom altitude profiles. Consequently, population calculations based on AEDT contours result in smaller exposed populations. **Tables 6-7** and **6-8** provide population results for the contour set for each given year, with the model noted.

Comparing Measured and Modeled Noise Levels

When changes in noise exposure are predicted through modeling, it is important to substantiate these modeled findings with actual noise measurements, such as those taken with Massport's permanent noise monitoring system. Massport's system continuously measures the noise levels at each of the 30 microphone locations around the Airport and environs, as shown in **Figure 6-15**. During normal operation, noise monitors at the microphone locations measure noise exposure levels as well as a variety of metrics associated with individual noise events that exceed preset threshold sound levels. Noise monitoring data are transmitted back to Massport's Noise Office, where daily DNL values and other noise metrics are computed for each location and summarized in various reports.

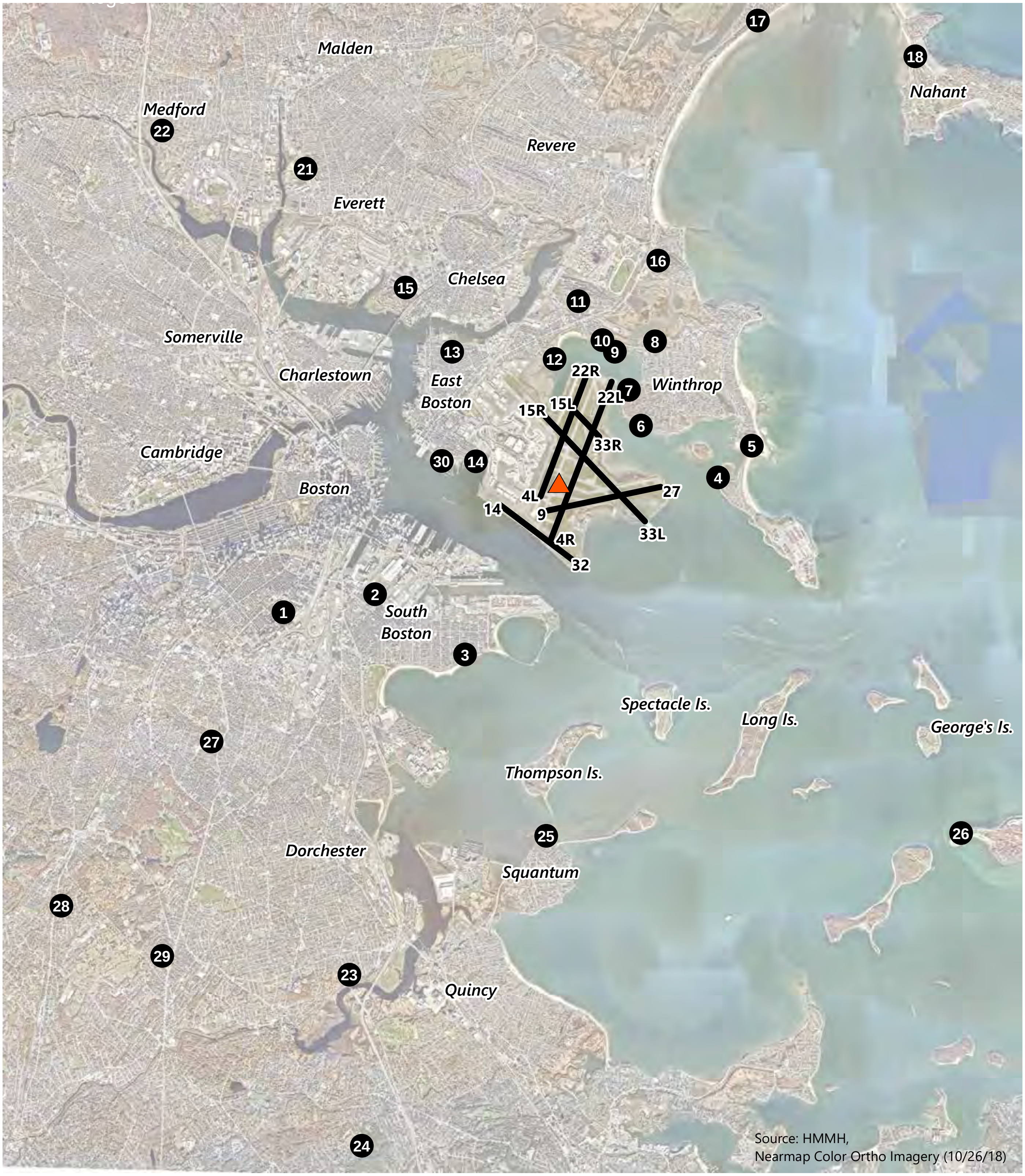


FIGURE 6-15 Noise Monitor Locations

2017 Environmental Status and Planning Report

● Permanent Noise Monitor

▲ Airport Reference Point

0 2000 4000 8000 Feet

All sites have been verified by survey.
Locations not shown on map:
#19 Smith Lane, Swampscott
#20 Pond and Town Court, Lynn

Table 6-9 compares the measured 2016 DNL values to the measured 2017 DNL values at each location. The average measured value for 26 of the 30 sites was 56.9 dB in 2017, an increase of 0.4 dB from the average of 56.5 dB in 2016. In 2017, three locations had measured decreases of 2 dB or more as compared to the 2016 value, while six had measured increases of more than 2 dB. Two sites did not have data for comparison. The remaining 19 locations had changes in levels of less than 2 dB.

Of the 30 noise monitor sites, four were not included in the average measured values for 2016 or 2017. Site 12 was decommissioned in 2010 and Site 26 was damaged and unavailable for most of 2016, although it resumed operation in September 2017. Therefore, Sites 12 and 26 are not included in any of the comparison analysis. One location, Site 14,[21] reported a measured aircraft DNL of only 23.7 dB in 2017, and another, Site 18,[22] reported a measured aircraft DNL of only 30.6 dB in 2016. These unusually low values resulted from periods of monitor malfunction. Therefore, the values for both of these sites for both years were removed from the averages to allow for a more accurate comparison.

Using AEDT, Massport can compute the modeled DNL for the same periods for which the noise monitoring system was collecting data at each site. It is also able to capture runway use and airspace changes as they occur. The model, however, only computes noise from aircraft (not street traffic or other local sound sources) and while it accounts for terrain, it does not include acoustical factors such as local weather phenomena or shielding from local buildings and trees. **Table 6-10** compares the measured 2016 and 2017 DNL values at each measurement site to the modeled DNL values. The AEDT model was used to compute DNL noise levels at each noise monitoring site for both years. The measured data are not used to calibrate the model but are shown here to compare to the modeled values and in general, they reveal similar trends.

Differences between measured and modeled values have narrowed over the years as both the noise monitoring and modeling processes have been refined. For 2017, the differences between measured and modeled DNL average 1.9 dB. For those same sites, the 2016 average difference between measured and modeled DNL was 2.1 dB. Because the modeled values are generally larger than the measured values, especially at the more distant monitors, the average difference is usually a positive value.

As shown in **Table 6-10**, 12 of the sites in 2017 differ between measured and modeled DNL values of 1 dB or less. At almost all of the sites where the difference is greater than 1 dB, the modeled value exceeds the measured value, the only exception being Site 6. Larger modeled values indicate that the contours tend to be conservative estimates of the noise. It is not unusual to experience larger differences between measured and modeled levels at the locations with measured DNL below 60 dB. The monitor identification of aircraft noise events becomes more difficult to differentiate from other noise sources, and long-distance noise attenuation effects can reduce actual levels that the model cannot duplicate. Larger differences at these sites, which tend to be farther from the airport, increase the average overall difference between measured and modeled results. Distances reported in **Tables 6-9** and **6-10** are computed from the Airport Reference Point which is located along Runway 4L-22R near its intersection with Runway 15R-33L. This location is shown in **Figure 6-15**.

21 Investigation revealed that the monitor settings at Site 14 were not allowing for identification of aircraft noise events.

22 The monitor at Site 18 had a series of component failures over the course of the year.

Table 6-9 Measured Versus Measured – Comparison of Measured DNL Values From 2016 to 2017

Location	Site	Distance from Logan Airport (miles)	2016 Measured Aircraft (DNL)	2017 Measured Aircraft (DNL)	Difference 2017 minus 2016
South End – Andrews Street	1	3.7	57.5	58.1	0.6
South Boston – B and Bolton	2	2.9	59.3	60.0	0.7
South Boston – Day Blvd. near Farragut	3	2.5	58.5	58.6	0.1
Winthrop – Bayview and Grandview	4	1.6	67.1	71.1	4.0
Winthrop – Harborview and Faun Bar	5	1.9	64.1	63.9	(0.2)
Winthrop – Somerset near Johnson	6	0.8	64.6	64.8	0.2
Winthrop – Loring Road near Court	7	1.0	65.8	64.5	(1.3)
Winthrop – Morton and Amelia	8	1.6	59.6	57.9	(1.7)
East Boston – Bayswater near Annavoy	9	1.3	66.6	60.6	(6.0)
East Boston – Bayswater near Shawsheen	10	1.3	57.7	61.3	3.6
East Boston – Selma and Orient	11	1.8	55.7	54.0	(1.7)
East Boston Yacht Club	12	1.2	N/A	N/A	N/A
East Boston High School	13	1.9	63.3	63.8	0.5
East Boston – Jeffries Point Yacht Club	14	1.2	44.9	23.7	(21.2)
Chelsea – Admiral's Hill	15	2.8	61.5	62.3	0.8
Revere – Bradstreet and Sales	16	2.4	68.7	68.3	(0.4)
Revere – Carey Circle	17	5.3	60.4	60.6	0.2
Nahant – U.S.C.G. Recreational Facility	18	5.9	30.6	43.4	12.8
Swampscott – Smith Lane	19	8.7	39.5	42.3	2.8
Lynn – Pond and Towns Court	20	8.4	53.9	51.9	(2.0)
Everett – Tremont near Prescott	21	4.5	51.7	55.4	3.7
Medford – Magoun near Thatcher	22	6.0	53.5	55.0	1.5
Dorchester – Myrtlebank near Hilltop	23	6.3	56.2	55.6	(0.6)
Milton – Cunningham Park near Fullers	24	8.1	49.4	48.0	(1.4)
Quincy – Squaw Rock Park	25	4.2	41.1	40.0	(1.1)
Hull – Hull High School near Channel Street	26	6.0	N/A	59.0	N/A
Roxbury – Boston Latin Academy	27	5.3	56.2	56.1	(0.1)
Jamaica Plain – Southbourne Road	28	7.7	49.7	50.6	0.9
Mattapan – Lewenburg School	29	7.3	38.2	42.6	4.4
East Boston – Piers Park	30	1.5	49.8	51.5	1.7
Arithmetic Average			**56.5**	56.9	0.4

Source: HMMH, 2018.

Notes: DNL - Day-Night Average Sound Level; N/A – not available.
Changes in ( ) represent a decrease in measured noise level.
Distance from Logan Airport calculated from the Airport Reference Point.
The monitor at Site 1 was removed in May 2017; Massport is reviewing options for relocation.
In 2017, Site 12 (East Boston Yacht Club) was not operational; it was relocated to Coleridge Street, East Boston and started to collect data in February 2018. After being damaged, Site 26 (Hull High School) resumed operation in September 2017. Sites 14 and 18 experienced long-term technical problems. These four sites are not included in the average values.
The average value for 2016 (56.5) differs from that published in the *2016 Environmental Data Report (EDR)* (55.2) which had included sites 14 and 18.

Table 6-10 Comparison of Measured DNL Values to AEDT Modeled DNL Values

			2016		2017		2016	2017
Location	**Site**	**Distance from Logan Airport (miles)[1]**	**Measured Aircraft – Only DNL**	**Modeled Results AEDT (DNL)**	**Measured Aircraft – Only DNL**	**Modeled Results AEDT (DNL)**	**Difference Modeled minus Measured**	
South End –	1	3.7	57.5	55.9	58.1	57.0	(1.6)	(1.1)
South	2	2.9	59.3	59.7	60.0	60.1	0.4	0.1
South	3	2.5	58.5	60.7	58.6	61.3	2.2	2.7
Winthrop –	4	1.6	67.1	71.8	71.1	72.5	4.7	1.4
Winthrop –	5	1.9	64.1	64.6	63.9	64.1	0.5	0.2
Winthrop –	6	0.8	64.6	61.9	64.8	62.2	(2.7)	(2.6)
Winthrop –	7	1.0	65.8	67.0	64.5	65.3	1.2	0.8
Winthrop –	8	1.6	59.6	61.3	57.9	60.2	1.7	2.3
East Boston	9	1.3	66.6	67.9	60.6	67.1	1.3	6.5
East Boston	10	1.3	57.7	62.3	61.3	61.3	4.6	(0.0)
East Boston	11	1.8	55.7	57.3	54.0	56.7	1.6	2.7
East Boston	12	1.2	N/A	65.3	N/A	66.1	N/A	N/A
East Boston	13	1.9	63.3	64.5	63.8	64.1	1.2	0.3
East Boston	14	1.2	44.9	61.0	23.7	62.1	16.1	38.4
Chelsea –	15	2.8	61.5	61.6	62.3	62.2	0.1	(0.1)
Revere –	16	2.4	68.7	67.7	68.3	67.8	(1.0)	(0.5)
Revere –	17	5.3	60.4	59.7	60.6	60.0	(0.7)	(0.6)
Nahant –	18	5.9	30.6	46.1	43.4	44.5	15.5	1.1
Swampscott	19	8.7	39.5	45.9	42.3	43.8	6.4	1.5
Lynn – Pond	20	8.4	53.9	54.8	51.9	54.8	0.9	2.9
Everett –	21	4.5	51.7	54.5	55.4	57.7	2.8	2.3
Medford –	22	6.0	53.5	53.8	55	55.7	0.3	0.7
Dorchester –	23	6.3	56.2	54.7	55.6	54.8	(1.5)	(0.8)
Milton –	24	8.1	49.4	54.2	48	52.5	4.8	4.5
Quincy –	25	4.2	41.1	49.5	40	49.6	8.4	9.6
Hull – Hull	26	6.0	N/A	59.3	59.0	60.0	N/A	1.0
Roxbury –	27	5.3	56.2	54.5	56.1	55.5	(1.7)	(0.6)
Jamaica	28	7.7	49.7	51.2	50.6	52.4	1.5	1.8
Mattapan –	29	7.3	38.2	48.2	42.6	49.3	10.0	6.7
East Boston	30	1.5	49.8	58.3	51.5	59.3	8.5	7.8
Arithmetic			**56.5**	**58.6**	**56.9**	**58.7**	**2.1**	**1.9**

Source: HMMH, 2018.
Note: DNL – Day-Night Average Sound Level. 2016 and 2017 modeled results were computed for the whole year.
1 Distance from Logan Airport calculated from the Airport Reference Point.
2 Sites 12, 14, 18, and 26 are not included in the average values due to monitor issues at those sites.

Supplemental Metrics

To further describe the noise environment, this *2017 ESPR* includes supplemental noise metrics: CNI, dwell and persistence, and times above a noise threshold.

Cumulative Noise Index (CNI)

Massport reports total annual fleet noise at Logan Airport, as defined in the Logan Airport Noise Rules by a metric referred to as CNI. CNI is a single number representing the sum of the entire set of single-event noise energy from each operation experienced at Logan Airport over a full year of operation. CNI is weighted similarly to DNL, meaning an extra 10 dB is added to each event occurring at night. This weighting is equivalent to multiplying the number of nighttime events of each aircraft by a factor of ten.

The Logan Airport Noise Rules define CNI in units of EPNdB[23] and require that the index be computed for the fleet of commercial aircraft operating at Logan Airport throughout the year. In addition, in EDRs and ESPRs, Massport reports partial CNI values of noise at Logan Airport, so that contributions from various subsets of the fleet (cargo, night operations, passenger jets, etc.) are identified. Using the expanded data available from the NOMS, all available aircraft registration data were used to select the proper noise certification levels from the latest aircraft noise registration database.[24]

The Noise Rules, adopted by Massport following public hearings held in February 1986, established a CNI limit of 156.5 EPNdB. As shown in the top lines of **Table 6-11**, the CNI generally has decreased since 1990, remaining below the cap, and typical changes from one year to the next have been within a few tenths of a dB. Since its 2010 minimum of 151.9 dB, the CNI has increased moderately. In 2017, the CNI increased by 0.5 dB over the 2016 value, to 153.1 EPNdB, remaining well below the cap of 156.5 EPNdB. The analysis of partial CNI values below helps to explain the yearly changes.

Partial Cumulative Noise Index (CNI) Calculations

Partial CNI values are obtained by summing the noise from particular segments of Logan Airport's total operations. They are useful for identifying the greatest contributors to overall noise. As shown in **Table 6-11**, the sectors of the fleet with the highest numbers of partial CNI indicate a greater contribution to total noise.

Since Stage 2 aircraft have not been a factor in the past several years, year-to-year changes can be best understood by examining the four shaded lines in **Table 6-11**. The partial CNI decreased the most for nighttime cargo operations and increased the most in nighttime passenger operations. The number of cargo operations has held relatively steady, while the number of passenger operations, particularly at night, has grown more significantly. Passenger operations dominate the cumulative noise because they comprise about 98 percent of commercial jet operations.

23 Effective Perceived Noise level (EPNdB) is the noise metric used to certify aircraft by the Federal Aviation Administration (FAA).

24 Type-certificate data sheet for noise database available from the European Aviation Safety Agency; http://www.easa.europa.eu/document-library/noise-type-certificates-approved-noise-levels.

Table 6-11 Cumulative Noise Index (CNI) (EPNdB)[1]

Full CNI (Entire Commercial Jet Fleet)	Logan Airport CNI Cap – 156.5 EPNdB					
	1990	**2000**	**2010**	**2016**	**2017**	**Change (2017-2016)**
	156.4	**154.7**	**151.9**	**152.6**	**153.1**	**0.5**
Total Passenger Jets	155.2	153.6	150.9	152.0	152.6	0.6
Total Cargo Jets	150.1	148.2	145.1	143.8	143.4	(0.4)
Total Daytime	152.5	149.5	146.8	147.0	147.5	0.5
Total Nighttime	154.4	153.1	150.3	151.2	151.7	0.5
Total Stage 2 Jets	N/A	124.7	113.6	N/A	N/A	N/A
Total Stage 3 Jets	N/A	154.7	151.9	152.6	153.1	0.5
Daytime Stage 2	N/A	122.6	103.6	N/A	N/A	N/A
Nighttime Stage 2	N/A	120.5	113.1	N/A	N/A	N/A
Daytime Stage 3	N/A	149.5	146.8	147.0	147.5	0.5
Nighttime Stage 3	N/A	153.1	150.3	151.2	151.7	0.5
Passenger Jet Stage 2	N/A	124.2	N/A	N/A	N/A	N/A
Passenger Jet Stage 3	N/A	153.6	150.9	152.0	152.6	0.6
Cargo Jet Stage 2	N/A	114.8	113.6	N/A	N/A	N/A
Cargo Jet Stage 3	N/A	148.2	145.1	143.8	143.4	(0.4)
Daytime Passenger	N/A	149.3	146.6	146.8	147.3	0.5
Nighttime Passenger	N/A	151.6	149.0	150.4	151.1	0.7
Daytime Cargo	137.1	137.5	134.5	133.8	133.9	0.1
Nighttime Cargo	149.9	147.8	144.7	143.4	142.8	(0.6)
Daytime Passenger Stage 2	N/A	122.3	N/A	N/A	N/A	N/A
Daytime Passenger Stage 3	N/A	149.2	146.6	146.8	147.3	0.5
Nighttime Passenger Stage 2	N/A	119.8	N/A	N/A	N/A	N/A
Nighttime Passenger Stage 3	N/A	151.6	149.0	150.4	151.1	0.7
Daytime Cargo Stage 2	N/A	111.1	103.6	N/A	N/A	N/A
Daytime Cargo Stage 3	N/A	137.5	134.4	133.8	133.9	0.1
Nighttime Cargo Stage 2	N/A	112.3	113.1	N/A	N/A	N/A
Nighttime Cargo Stage 3	N/A	147.8	144.7	143.4	142.8	(0.6)

Source: HMMH, 2018.
Notes: General aviation and non-jet aircraft are not included in the calculation.
N/A Not available.
1 Data for years prior to 2016 are available in Appendix H, *Noise Abatement*.

Table 6-12 provides the number of flight operations, the resulting CNI by airline for 2016 and 2017, and the partial CNI per operation for 2016 and 2017. The table shows the relative contribution of each airline to total CNI and reflects the contributions of individual aircraft noise levels and the frequency with which they occur. The table is sorted by the partial CNI per operation for 2017 and shows a mix of international carriers and cargo operators at the top of this list. This is due to the higher proportion of nighttime operations among these carriers, as well as the operation of larger and/or older aircraft. jetBlue Airways, with the largest number of operations, has the highest CNI per airline at 146.4 EPNdB in 2016 and 147.3 EPNdB in 2017, but its partial CNI by operation is well below the other major airlines in part due to its use of newer, quieter aircraft. FedEx has less than 4 percent of the operations of jetBlue Airways but its total CNI per airline is 142.3 EPNdB in 2016 and 141.3 EPNdB in 2017, only 6 dB below jetBlue Airways in 2017. The partial CNI by operation for FedEx is among the highest of all airlines due to its use of older DC10 and MD11 aircraft and operations at night. These are the primary aircraft in the FedEx fleet and account for half of its nighttime operations. The noisier signatures of these aircraft combined with the 10-dB nighttime DNL weighting results in the proportionally larger FedEx contribution to the CNI.

Regional carriers generally contribute the least to the partial CNI per operation whereas the international carriers, which operate larger aircraft and generally have more operations at night, are just below the cargo operators in rank. The relative positions for the domestic carriers are due mainly to their fleet characteristics and number of night operations. United Airlines and Southwest Airlines each have over 11,000 fewer operations than Delta Air Lines and many fewer than jetBlue Airways; however, 23 percent and 20 percent of United Airlines and Southwest Airlines operations, respectively, are at night. jetBlue Airways had about 18 percent of its operations at night in 2017. Delta Air Lines had almost 17 percent of its operations at night, but it flies an older and larger fleet including MD-80s and Boeing 767s.

Table 6-12 Annual Operations by Partial CNI by Airline and per Operation, 2016 and 2017

Airlines with more than 100 flights in 2017	Operations	Total Airline CNI (EPNdB)	Operations	Total Airline CNI (EPNdB)	Partial CNI (EPNdB) per Operation		Airline Category
	2016	2016	2017	2017	2016	2017	
El Al Israel Airlines Ltd.	296	132.1	298	130.8	107.3	106.0	International
FedEx	3,896	142.3	3,755	141.3	106.4	105.6	Cargo
Cathay Pacific	454	132.1	652	133.7	105.5	105.6	Regional
United Parcel Service	1,834	138.0	2,053	138.5	105.3	105.4	Cargo
Atlas Air	N/A	N/A	136	126.4	N/A	105.0	Cargo
British Airways	2,702	139.0	2,522	136.1	104.6	102.1	International
Emirates Airlines	1,382	132.0	1,034	131.7	100.6	101.6	International
ATI	502	128.0	326	126.2	101.0	101.0	Cargo
Alitalia	558	128.0	548	127.7	100.5	100.4	International
MN Airlines, LLC	1,374	131.1	1,391	131.2	99.7	99.8	Regional
SATA Int'l Airlines	630	127.1	844	128.6	99.1	99.4	International
Turkish Airlines	658	129.2	616	127.2	101.0	99.3	Regional
United Airlines	25,052	143.0	24,636	143.1	99.0	99.1	Domestic
Southwest Airlines	24,436	142.9	24,129	142.9	99.0	99.1	Domestic
Alaska Airlines	3,256	133.7	3,351	134.2	98.5	98.9	Domestic
Virgin Atlantic	715	128.0	764	127.6	99.5	98.8	International
Avianca	N/A	N/A	226	122.2	N/A	98.6	International
Swiss Air	1,020	128.5	924	128.1	98.4	98.4	International
Virgin America	3,724	133.3	3,754	133.7	97.6	98.0	Domestic
Icelandair	1,358	126.5	1,265	129.1	95.1	98.0	International
Air France	900	128.2	884	127.4	98.6	97.9	International
Air Berlin	192	120.1	278	122.3	97.3	97.9	International
Lufthansa	1,728	134.7	1,707	130.1	102.3	97.8	International
Delta Air Lines	33,935	142.4	35,921	143.2	97.0	97.7	Domestic
Aeromexico	580	123.2	667	125.9	95.5	97.7	International
American Airlines	55,782	142.6	51,296	144.7	95.1	97.6	Domestic
jetBlue Airways	91,736	146.4	100,892	147.3	96.8	97.3	Domestic

Table 6-12 Annual Operations and Partial CNI by Airline and per Operation, 2016 and 2017 (Continued)

Airlines with more than 100 flights in 2017	Operations	Total Airline CNI (EPNdB)	Operations	Total Airline CNI (EPNdB)	Partial CNI (EPNdB) per Operation		Airline Category
	2016	2016	2017	2017	2016	2017	
Sky Regional Airlines	2,738	129.8	1,470	129.0	95.4	97.3	International
Norwegian Air Shuttle	656	125.9	767	126.1	97.7	97.3	International
Aer Lingus	2,066	129.0	2,011	129.9	95.8	96.9	International
TAP - Air Portugal	378	122.7	643	125.0	96.9	96.9	International
Iberia Air Lines	412	123.2	464	123.6	97.0	96.9	International
Spirit Airlines	7,245	134.5	8,853	135.7	95.9	96.2	Domestic
Shuttle America Corp	6,546	133.0	418	122.4	94.9	96.2	Regional
Thomas Cook Airlines	N/A	N/A	154	117.7	N/A	95.9	International
Hainan Airlines Co. Ltd.	961	123.2	1,032	125.8	93.4	95.7	International
Qatar Airways	552	126.4	728	124.3	99.0	95.7	International
Japan Airlines	736	125.7	730	124.1	97.1	95.5	International
WOW Air, LLC.	678	116.4	724	124.0	88.1	95.4	International
Republic Airlines	1,458	125.8	11,994	136.1	94.2	95.3	Regional
Scandinavian Airlines	500	120.4	536	122.1	93.4	94.8	International
Compañía Panameña	638	121.8	730	122.9	93.8	94.2	International
Air Canada	2,713	128.9	3,947	129.6	94.6	93.7	International
Endeavor Air	1,377	123.7	7,977	132.2	92.3	93.2	Domestic
GoJet Airlines	2,783	128.3	3,136	127.9	93.9	92.9	Domestic
Mesa Airlines	486	117.3	327	117.5	90.5	92.4	Regional
ExpressJet	4,032	126.3	3,660	127.0	90.3	91.3	Domestic
Air Wisconsin	5,010	128.1	3,727	126.6	91.1	90.9	Regional
Jazz Air Inc.	5,832	127.4	5,947	128.6	89.7	90.8	Regional
Piedmont Airlines	N/A	N/A	729	118.9	N/A	90.2	Regional

Source: Massport and HMMH, 2018.
Notes: CNI – Cumulative Noise Index
N/A Not available; airline had no operations at Logan Airport.
1 Operations for some carriers differ to those in Chapter 2, *Activity Levels,* and Chapter 7, *Air Quality/Emissions Reduction,* because this table only includes jet aircraft and not turboprops, and because it includes both scheduled and unscheduled air carriers.

Dwell and Persistence Reduction Goals

Another supplemental measure of noise impact relates to the length of time for which noise impacts occur. To provide temporary relief to neighborhoods affected by regular overflights during single- or multi-day periods, the PRAS Advisory Committee established two short-term goals for the system in addition to the annual goals:

- Provide relief from excessive dwell. Exceedance is defined as more than seven hours of operations over a given area during any day between the hours of 7:00 AM and midnight.
- Provide relief from excessive persistence. Exceedance is defined as more than 23 hours of operations over an area between 7:00 AM and midnight during a period of three consecutive days.

In contrast to the annual PRAS goals that count the number of equivalent operations on a runway, dwell and persistence are measured by the number of hours that a given location or area is subject to jet aircraft overflights. The PRAS Advisory Committee designated eight runway end combinations for computing the effects of dwell and persistence on the communities, as shown in **Table 6-13**.

Table 6-13 Representative Neighborhoods near Logan Airport Affected by Runway Use

Runway	Representative Affected Neighborhoods
4L and 4R Arrivals	South Boston (Farragut St.), Dorchester, Quincy, Milton, Weymouth, and Braintree
32 and 33L Arrivals	Boston Harbor, Hull, Cohasset, Hingham, Scituate, and other South Shore locations
14 and 15R Departures	Boston Harbor, Hull, Cohasset, Hingham, Scituate, and other South Shore locations
22L and 22R Departures	South Boston (Farragut Street), Boston Harbor, Hull, Cohasset, Hingham, Scituate, and other South Shore locations
27 Departures	South Boston (Fan Pier), Roxbury, Jamaica Plain, South End, West Roxbury, Roslindale, Brookline, Hyde Park, and other points South and West
4L and 4R Departures plus 22L and 22R Arrivals	East Boston (Bayswater, Orient Heights), Winthrop (Court Road), Revere, and Nahant
9 Departures plus 27 Arrivals	Winthrop (Point Shirley), Boston Harbor, and other points North
33 Departures plus 15 Arrivals	East Boston (Eagle Hill), Chelsea, Everett, Medford, Somerville, Arlington, Cambridge, Belmont, and other points South and West

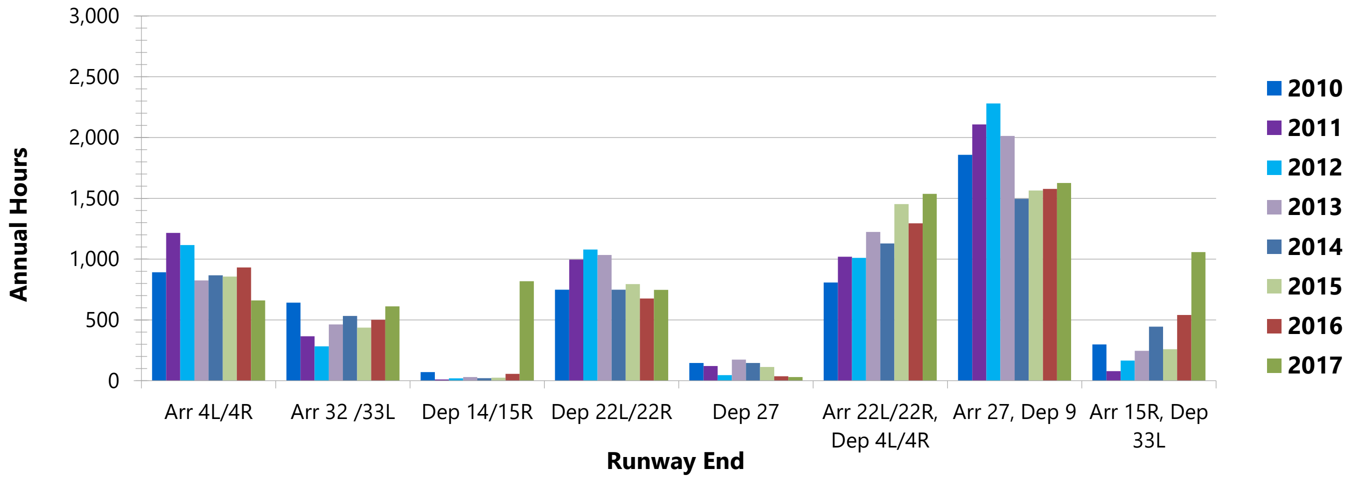
Source: Massport.

As required by Massport's commitments for the Logan Airside Improvements Planning Project,[25] this *2017 ESPR* reports on noise dwell and persistence levels. Higher levels of dwell or persistence for over-water areas represent a benefit since this produces a corresponding decrease in total hours over populated areas. **Figures 6-16** and **6-17** illustrate the annual hours of dwell and persistence by runway end for 2010 through 2017.

25 Federal Aviation Administration. 2002. *Logan Airside Improvements Planning Project Final EIS*.

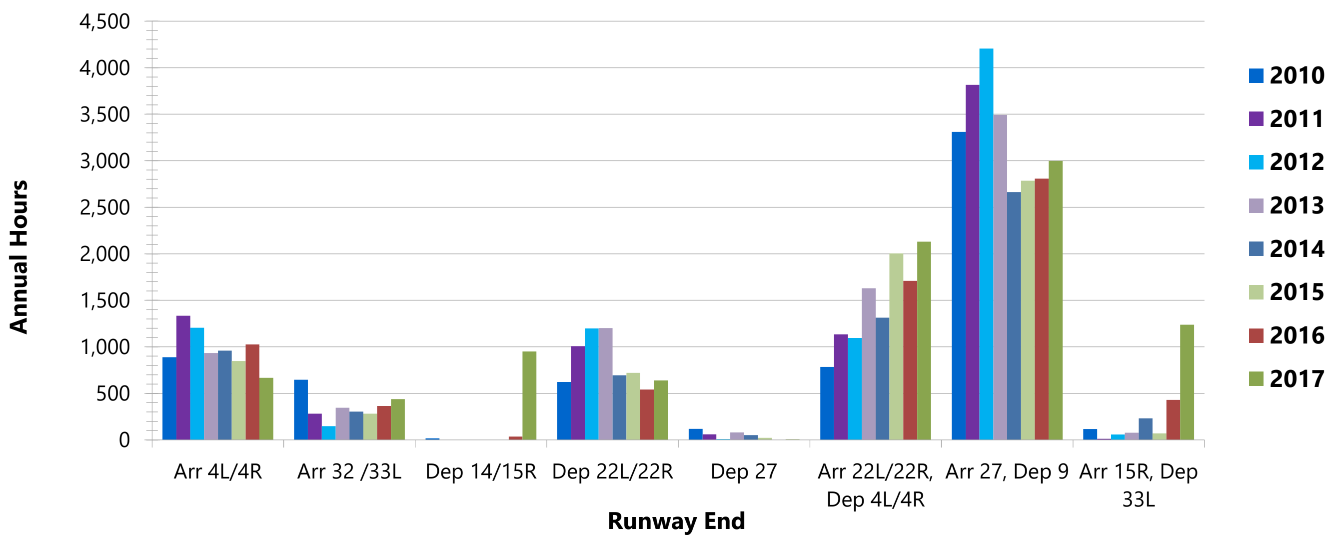
In general, 2017 dwell and persistence analysis results for 2015, 2016, and 2017 are quite similar. The most marked difference in both metrics for 2017 is the increase in hours of configurations including Runway 15R departures and the increase in hours on the other side of the airport, in configurations including Runway 33L departures.

Figure 6-16 Comparison of Annual Hours of Dwell Exceedance by Runway End, 2010 to 2017



Source: HMMH, 2018.
Note: Data for 2014, 2015, and 2016 corrected from previously published results.

Figure 6-17 Comparison of Annual Hours of Persistence Exceedance by Runway End, 2010 to 2017



Source: HMMH, 2018.
Note: Data for 2014, 2015, and 2016 corrected from previously published results.

Time Above (TA)

The third supplemental noise metric reported in this *2017 ESPR* is the amount of time that aircraft noise is above each of three predefined threshold sound levels. The measure is referred to generally as TA, and the threshold sound levels used in the analysis are 65, 75, and 85 dBA. Like DNL values, for 2017 these times are computed using the FAA-approved AEDT. The calculations are made at each of Massport's permanent noise monitoring locations and are based on an average 24-hour day during the year as well as the average nine-hour nighttime period from 10:00 PM to 7:00 AM. The threshold sound levels of 65, 75, and 85 dBA reflect different degrees of speech interference depending on factors such as whether people are outdoors, indoors with their windows open, or indoors with windows closed. **Tables 6-14** and **6-15** present a summary of the AEDT-calculated TA values for 2016 and 2017.

Table 6-14 Time Above (TA) dBA Thresholds in a 24-Hour Period for Average Day

			Minutes above Threshold						Modeled DNL (dB)[1]	
			2016			2017			2016	2017
Location	**Site**	**Distance (mi)**	**85 dBA**	**75 dBA**	**65 dBA**	**85 dBA**	**75 dBA**	**65 dBA**		
South End – Andrews Street	1	3.7	0.0	0.1	14.4	0.0	0.1	18.0	55.9	57.0
South Boston – B and Bolton	2	2.9	0.0	2.2	22.5	0.0	1.7	28.4	59.7	60.1
South Boston – Day Blvd. near Farragut	3	2.5	0.0	2.2	60.6	0.0	3.3	58.5	60.7	61.3
Winthrop – Bayview and Grandview	4	1.6	8.1	43.0	106.0	9.0	42.5	110.1	71.8	72.5
Winthrop – Harborview and Faun Bar	5	1.9	0.1	15.3	83.0	0.1	11.3	85.7	64.6	64.1
Winthrop – Somerset near Johnson	6	0.8	0.0	1.4	53.9	0.0	1.1	58.3	61.9	62.2
Winthrop – Loring Road near Court	7	1	1.0	10.8	84.2	0.5	6.6	84.3	67.0	65.3
Winthrop – Morton and Amelia	8	1.6	0.1	3.7	32.9	0.0	1.8	30.6	61.3	60.2
East Boston – Bayswater near Annavoy	9	1.3	1.2	20.3	72.1	0.7	18.4	74.3	67.9	67.1
East Boston – Bayswater near Shawsheen	10	1.3	0.1	5.2	45.7	0.1	3.0	42.6	62.3	61.3
East Boston – Selma and Orient	11	1.8	0.0	1.2	14.7	0.0	0.5	11.8	57.3	56.7
East Boston Yacht Club	12	1.2	0.0	8.2	124.6	0.0	10.3	141.7	65.3	66.1
East Boston High School	13	1.9	0.3	10.9	40.5	0.1	9.6	58.4	64.5	64.1

Table 6-14 Time Above (TA) dBA Thresholds in a 24-Hour Period for Average Day (Continued)

			Minutes above Threshold						Modeled DNL (dB)[1]	
			2016			2017			2016	2017
Location	**Site**	**Distance (mi)**	**85 dBA**	**75 dBA**	**65 dBA**	**85 dBA**	**75 dBA**	**65 dBA**		
East Boston – Jeffries Point Yacht Club	14	1.2	0.0	0.6	47.6	0.0	0.6	61.8	61.0	62.1
Chelsea – Admiral's Hill	15	2.8	0.1	4.7	32.2	0.0	5.2	51.0	61.6	62.2
Revere – Bradstreet and Sales	16	2.4	1.1	19.4	50.8	1.3	18.3	44.9	67.7	67.8
Revere – Carey Circle	17	5.3	0.0	0.6	37.2	0.0	0.9	38.6	59.7	60.0
Nahant – U.S.C.G. Recreational Facility	18	5.9	0.0	0.0	0.6	0.0	0.0	0.3	46.1	44.5
Swampscott – Smith Lane	19	8.7	0.0	0.0	0.9	0.0	0.0	0.4	45.9	43.8
Lynn - Pond and Towns Court	20	8.4	0.0	0.0	11.3	0.0	0.0	12.0	54.8	54.8
Everett – Tremont near Prescott	21	4.5	0.0	0.1	12.4	0.0	0.8	24.9	54.5	57.7
Medford – Magoun near Thatcher	22	6	0.0	0.2	9.5	0.0	0.2	14.8	53.8	55.7
Dorchester – Myrtlebank near Hilltop	23	6.3	0.0	0.0	12.0	0.0	0.0	17.8	54.7	54.8
Milton – Cunningham Park near Fullers	24	8.1	0.0	0.0	10.5	0.0	0.0	7.2	54.2	52.5
Quincy – Squaw Rock Park	25	4.2	0.0	0.0	0.4	0.0	0.0	0.3	49.5	49.6
Hull – Hull High School near Channel Street	26	6	0.0	0.2	26.9	0.0	0.2	33.0	59.3	60.0
Roxbury – Boston Latin Academy	27	5.3	0.0	0.1	11.9	0.0	0.1	14.4	54.5	55.5
Jamaica Plain - Southbourne Road	28	7.7	0.0	0.0	3.3	0.0	0.0	4.0	51.2	52.4
Mattapan – Lewenburg School	29	7.3	0.0	0.0	0.3	0.0	0.0	0.2	48.2	49.3
East Boston – Piers Park	30	1.5	0.0	0.2	16.0	0.0	0.2	21.6	58.3	59.3
Average TA Value[2]			**0.4**	**5.0**	**34.6**	**0.4**	**4.6**	**38.3**		

Source: HMMH, 2018.
Notes: dBA - A-weighted decibel; dB – decibel; DNL - Day-Night Average Sound Level.
Distance from Logan Airport calculated from the Airport Reference Point.
1 2016 and 2017 modeled with AEDT (2016 with version 2c SP2, 2017 with version 2d).
2 Arithmetic average includes all noise monitoring sites.

Table 6-15 Time Above (TA) dBA Thresholds in a Nine Hour Night Period for Average Day[1]

			Minutes above Threshold						Modeled DNL (dB)[2]	
			2016			2017			2016	2017
Location	**Site**	**Distance (mi)**	**85 dBA**	**75 dBA**	**65 dBA**	**85 dBA**	**75 dBA**	**65 dBA**		
South End – Andrews Street	1	3.7	0.0	0.0	3.4	0.0	0.0	4.7	55.9	57.0
South Boston – B and Bolton	2	2.9	0.0	0.6	5.0	0.0	0.5	7.2	59.7	60.1
South Boston – Day Blvd. near Farragut	3	2.5	0.0	0.1	7.0	0.0	0.3	6.5	60.7	61.3
Winthrop – Bayview and Grandview	4	1.6	1.1	5.0	13.9	1.5	5.5	15.1	71.8	72.5
Winthrop – Harborview and Faun Bar	5	1.9	0.0	1.6	9.6	0.0	1.1	10.8	64.6	64.1
Winthrop – Somerset near Johnson	6	0.8	0.0	0.3	9.5	0.0	0.3	10.1	61.9	62.2
Winthrop – Loring Road near Court	7	1	0.2	1.6	14.1	0.1	0.8	13.6	67.0	65.3
Winthrop – Morton and Amelia	8	1.6	0.0	0.5	6.3	0.0	0.2	6.0	61.3	60.2
East Boston – Bayswater near Annavoy	9	1.3	0.2	3.9	12.4	0.1	3.5	12.6	67.9	67.1
East Boston – Bayswater near Shawsheen	10	1.3	0.0	0.6	8.2	0.0	0.3	7.7	62.3	61.3
East Boston – Selma and Orient	11	1.8	0.0	0.1	2.0	0.0	0.1	1.8	57.3	56.7
East Boston Yacht Club	12	1.2	0.0	1.9	19.3	0.0	2.5	22.0	65.3	66.1
East Boston High School	13	1.9	0.1	1.9	6.2	0.0	1.9	9.5	64.5	64.1
East Boston – Jeffries Point Yacht Club	14	1.2	0.0	0.1	9.3	0.0	0.2	12.5	61.0	62.1
Chelsea – Admiral's Hill	15	2.8	0.0	1.0	4.8	0.0	1.2	8.2	61.6	62.2
Revere – Bradstreet and Sales	16	2.4	0.3	4.0	9.7	0.3	3.7	8.3	67.7	67.8
Revere – Carey Circle	17	5.3	0.0	0.1	7.8	0.0	0.2	7.8	59.7	60.0
Nahant – U.S.C.G. Recreational Facility	18	5.9	0.0	0.0	0.1	0.0	0.0	0.0	46.1	44.5
Swampscott – Smith Lane	19	8.7	0.0	0.0	0.1	0.0	0.0	0.0	45.9	43.8

Table 6-15 Time Above (TA) dBA Thresholds in a Nine Hour Night Period for Average Day[1] (Continued)

			Minutes above Threshold						Modeled DNL (dB)[2]	
			2016			2017			2016	2017
Location	**Site**	**Distance (mi)**	**85 dBA**	**75 dBA**	**65 dBA**	**85 dBA**	**75 dBA**	**65 dBA**		
Lynn - Pond and Towns Court	20	8.4	0.0	0.0	2.7	0.0	0.0	2.8	54.8	54.8
Everett – Tremont near Prescott	21	4.5	0.0	0.0	2.2	0.0	0.1	4.3	54.5	57.7
Medford – Magoun near Thatcher	22	6	0.0	0.1	1.8	0.0	0.1	2.8	53.8	55.7
Dorchester – Myrtlebank near Hilltop	23	6.3	0.0	0.0	1.5	0.0	0.0	2.1	54.7	54.8
Milton – Cunningham Park near Fullers	24	8.1	0.0	0.0	1.4	0.0	0.0	0.8	54.2	52.5
Quincy – Squaw Rock Park	25	4.2	0.0	0.0	0.0	0.0	0.0	0.0	49.5	49.6
Hull – Hull High School near Channel Street	26	6.0	0.0	0.1	7.6	0.0	0.1	9.5	59.3	60.0
Roxbury – Boston Latin Academy	27	5.3	0.0	0.0	2.8	0.0	0.0	3.8	54.5	55.5
Jamaica Plain - Southbourne Road	28	7.7	0.0	0.0	0.9	0.0	0.0	1.2	51.2	52.4
Mattapan – Lewenburg School	29	7.3	0.0	0.0	0.1	0.0	0.0	0.0	48.2	49.3
East Boston – Piers Park	30	1.5	0.0	0.0	3.9	0.0	0.0	5.5	58.3	59.3
Average TA Value[3]			**0.1**	**0.8**	**5.8**	**0.1**	**0.7**	**6.6**		

Source: HMMH, 2018.

Notes: dBA - A-weighted decibel; dB – decibel; DNL - Day-Night Average Sound Level.
Distance from Logan Airport calculated from the Airport Reference Point.

1 Nine-hour nighttime period from 10:00 PM – 7:00 AM.

2 2016 and 2017 modeled with AEDT (2016 with version 2c SP2, 2017 with version 2d).

3 Arithmetic average includes all noise monitoring sites.

Future Planning Horizon

The Future Planning Horizon operations forecast (described in detail in Chapter 2, *Activity Levels*), applied to a set of runway use assumptions described in the following sections, was used to forecast noise contours. Flight tracks and track use were developed from the current radar data sets and were used as AEDT inputs for the forecast case. The resulting noise contours represent Massport's best estimates of future noise levels for a year when annual passenger counts reach 50 million and operations reach over 486,000. The *2017 ESPR* presents these results along with the associated population impact analysis.

Forecast Fleet Mix and Operation Assumptions

The long-range forecast developed for Logan Airport includes a 22.8-percent increase in commercial aircraft operations and a modest 1.6-percent increase in GA operations compared to 2017. The Future Planning Horizon fleet, which assumes a passenger level of 50 million annual air passengers, includes a larger percentage of newer aircraft (Boeing 787, 737 Max, Airbus 220, and Airbus Neo variants), and 59.2 percent more RJ operations. These new aircraft types are projected to be more fuel efficient and generate less noise. The projected increase in total operations is 21.1 percent over the 2017 count. Over the same time period, passengers are expected to increase by 30.5 percent, continuing the trend of increasing load factors.

Total operations are expected to increase by about 230 operations per day, from almost 1,100 per day in 2017 to over 1,330 per day in the Future Planning Horizon forecast. The total numbers of nighttime operations for the forecast scenario and for 2017 are nearly equal (167.75 and 167.55, respectively), due to airline scheduling and accommodation of international time zones. It is expected that the majority of nighttime operations in the future will continue to occur either before midnight or after 5:00 AM.

The forecast assumes all Stage 3 recertificated aircraft (aircraft that were certified Stage 2 when they were manufactured, but were later modified to qualify for Stage 3 certification) would be phased out by this period. The forecast includes some originally certified Stage 3 aircraft (1.6 percent of jet operations) and expects the remainder will be in Stage 4 (42.5 percent) and Stage 5 (55.9 percent).

Table 6-16 summarizes the forecast operations by commercial and GA aircraft in comparison to the 2017 fleet.

Table 6-16 Modeled Daily Operations, 2017 and Future Planning Horizon

	2017			Future Planning Horizon		
	Day	Night	**Total**	Day	Night	**Total**
Air Carrier Jets	636.0	148.8	**784.8**	805.3	144.7	**950.0**
Regional Jets (RJ)	98.4	9.7	**108.2**	158.3	13.9	**172.2**
Commercial Non-Jets	119.0	2.2	**121.3**	120.9	2.6	**123.5**
Total Commercial Operations	853.5	160.7	**1,014.2**	1,084.5	161.2	**1,245.7**
General Aviation (GA) Jets	52.2	4.6	**56.8**	44.7	2.8	**47.5**
GA Non-Jets	26.4	2.3	**28.7**	35.6	3.8	**39.3**
Total GA Operations	78.6	6.8	**85.4**	80.2	6.6	**86.8**
Total Modeled Operations	**932.1**	**167.6**	**1,099.7**	**1,164.8**	**167.8**	**1,332.5**

Source: 2000, 2010, and 2017 data - HMMH and Massport's Noise Monitoring System.
Future Planning Horizon data - Massport Long-Range Forecast.
Notes: Totals may not add exactly due to rounding. Changes in ( ) represent a decrease.

The Future Planning Horizon forecast fleet would primarily comprise jets, resulting in the continued use of the largest capacity runway configurations. In order to generate a runway usage table for the Future Planning Horizon, Massport used current radar counts taken from periods of normal airport operations (i.e., no runway closures) and accounting for all seasonal variations.[26] The results were then compared to historical runway usage patterns and adjusted slightly. Although it is challenging to accurately predict a future year's runway usage, Massport has relied on best-available information to develop this estimate. Future ESPR documents will revisit the forecast assumptions using data collected for and reported on in the intervening EDR documents. **Table 6-17** compares the 2017 jet runway use to the forecast Future Planning Horizon jet runway use. As noted previously in this chapter, 2017 runway use was affected by the closure of Runway 4R-22L.[27] Runway use for 2000 and 2010 is also shown in **Table 6-17** for historical context.

Departures for the Future Planning Horizon on Runways 4R, 9, 22L, and 22R would be somewhat higher than in 2017, while departures on Runways 27 and 33L would be lower. Arrivals for the Future Planning Horizon on Runways 4L, 15R, 27 and 33L are predicted to be lower than for 2017, while use of Runways 4R and 22L is expected to increase.

26 The radar counts from January 1 through May 15 of 2017, May 16 through September 15 of 2016, and September 16 through December 31 of 2017 were the basis for the forecast runway use.

27 Runway 4R-22L was closed from May 15 to June 23 (35 days), with limited availability for Runway 4R arrivals through September 15th.

Table 6-17 Summary of Jet Aircraft Runway Use, Including Future Planning Horizon

Departures					Arrivals				
Runway	**2000**	**2010**	**2017**	**Future Planning Horizon**	**Runway**	**2000**	**2010**	**2017**	**Future Planning Horizon**
4L	--	--	--	--	4L	4%	5%	5%	4%
4R	8%	4%	2%	4%	4R	40%	28%	21%	30%
9	35%	28%	25%	29%	9	--	--	--	--
14	N/A	<1%	--	--	14	N/A	--	--	--
15L	--	--	--	--	15L	--	--	--	--
15R	4%	8%	5%	5%	15R	1%	1%	5%	1%
22L	3%	2%	1%	2%	22L	7%	15%	23%	26%
22R	30%	31%	28%	30%	22R	--	--	<1%	--
27	15%	10%	15%	12%	27	28%	32%	27%	23%
32	N/A	--	--	--	32	N/A	1%	2%	2%
33L	6%	17%	23%	18%	33L	20%	16%	18%	15%
33R	--	--	--	--	33R	--	--	--	--

Source: HMMH and Massport, 2019.
Notes: Totals may not add exactly due to rounding. Changes in ( ) represent a decrease in runway use. Negative percent changes represent decrease in use. N/A for Runway 14-32 in 2000 indicates that the runway was not built yet. Percentages for 2000, 2010 and 2017 are actual jet runway use; Future Planning Horizon percentages compiled from historical data as described in text.
1 Percent change compares 2017 and the Future Planning Horizon.

Day-Night Noise Contours for the Future Planning Horizon

Figure 6-18 presents the comparison between the 2017 DNL contours and the Future Planning Horizon DNL contours. The area contained within the forecast contours is generally larger than the area within the 2017 contours due to the expected growth in number of operations. As noted in the discussion of forecast operations, the total number of nighttime operations for the forecast scenario (an average nightly 167.75) is almost the same as in 2017, while the daytime operations are expected to grow from an average 932 operations to 1,165 daily (25 percent increase). However, the forecast contours show increased noise compared to the 2017 contours in some areas, while not extending as far as the 2017 contours in other regions. The runway usage is the controlling factor over the general distribution of noise.

Beginning on the west side of the airport, and moving clockwise, the contour changes from 2017 to the Future Planning Horizon are as follows:

- The bump in the DNL 65 dB contour extending southwest beyond the Runway 9 end is larger in the forecast case due to the expected fleet mix changes to larger aircraft. Since there are no arrivals to Runway 9, the contour in that area is affected only by departures from Runway 27. The extent of the 2017 and forecast case DNL 60 dB contours over the Fort Point area of Boston are the same.
- The lobe of the DNL 65 dB contour extending northwest beyond the Runway 15R end is slightly shorter and narrower for the forecast case in comparison to 2017, due to decreased Runway 15R arrivals and decreased Runway 33L departures. This noise decrease is more evident in the comparison of the DNL 60 dB contours over Chelsea and into Everett.
- To the north, the DNL 65 dB forecast contour is slightly wider than for 2017, and it extends further past the shoreline, due to the increases in both arrivals to Runway 22L and departures from Runway 4R. The DNL 60 dB contour echoes the same increases, extending further into the Point of Pines area of Revere.
- The lobes of the forecast DNL 65 dB and DNL 60 dB contours extending eastward over Winthrop are wider than for 2017 due to increased departures from Runway 9, but they are slightly shorter due to decreased Runway 27 arrivals.
- The lobes of the DNL 65 dB and DNL 60 dB contours extending southeast beyond the Runway 33L end are slightly shorter (over Long Island and the tip of Hull) in the forecast case than for 2017 due to decreased Runway 33L arrivals.
- Directly south of the airport, the DNL 65 dB contour is wider for the forecast case than for 2017, and the forecast DNL 60 dB contour reaches Spectacle Island as an effect of increased departures from Runways 22R and 22L.
- The lobes of the DNL 65 dB and DNL 60 dB contours extending south (toward Dorchester and Quincy) is both wider and longer for the forecast case in comparison to 2017, due to increased Runway 4R arrivals.

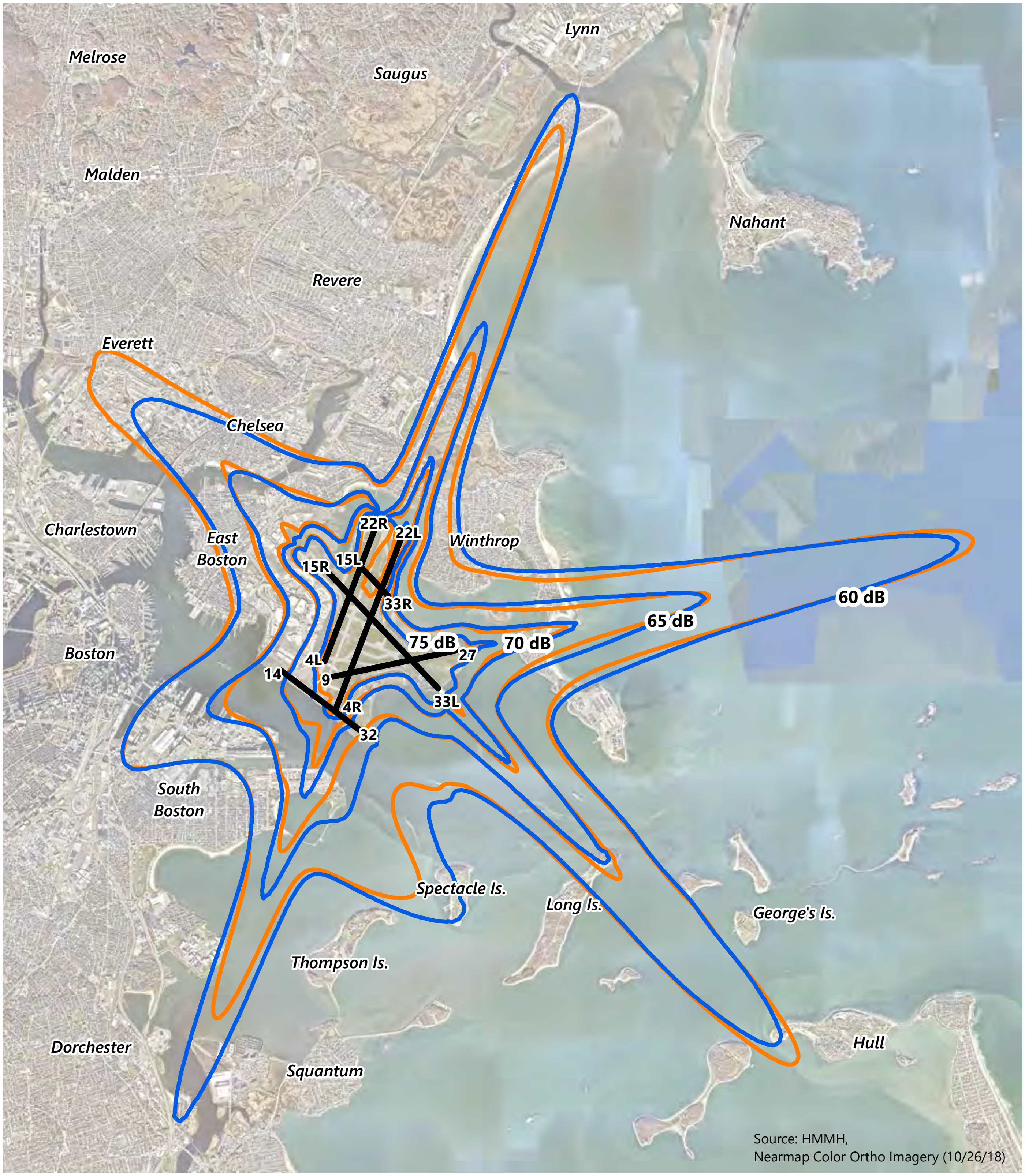


FIGURE 6-18 Comparison of the DNL 60-75 dB Contours for 2017 and Future Planning Horizon with AEDT 2d

2017 Environmental Status and Planning Report

2017 DNL Contour (AEDT 2d)

Future Planning Horizon DNL Contour (AEDT 2d)

0 2500 5000 10000 Feet

Population counts by contour interval are summarized in **Table 6-18**.[28] The DNL contours prepared for the higher level of operations in the Future Planning Horizon forecast result in 8,356 people exposed to noise levels of DNL 65 dB or greater. This is a modest increase from the 7,933 people exposed to noise levels greater than or equal to DNL 65 dB in 2017. The expected modernization of the fleet mix and forecast day/night split moderate the effect of the increased operations. The forecast population within DNL 65 dB is significantly less than the 17,745 people exposed to DNL 65 dB or above in 2000, when daily operations were also over 1,300). **Table 6-18** also shows that in the year 2000, a larger number of people were exposed to DNL 70 dB and above than in the Future Planning Horizon forecast scenario (219 in the forecast compared to 1,551 in 2000).

The Future Planning Horizon DNL 65 dB contour remains within areas that are sound insulated by Massport and surround the Airport. The aircraft in the forecast fleet for the Future Planning Horizon scenario are likely to have quieter and more efficient engines than aircraft flown today. The noise modeling relies on an extensive database of aircraft noise and performance profiles within AEDT and must use current versions of aircraft as "substitutes" for future types. Therefore, the Future Planning Horizon DNL contours presented in this chapter are a conservative estimate of the future noise levels. It is expected, with the continued advancement in aircraft technology resulting in quieter engines, that the actual noise levels would be lower.

While noise levels are expected to increase modestly from 2017 to the Future Planning Horizon forecast, they remain well below historic peaks. The number of people in Revere exposed to sound levels of DNL 65 dB or greater is predicted to increase due to higher use of Runway 22L for arrivals and Runway 4R for departures. In Winthrop, the number of people living within the DNL 65 dB contour and within the DNL 70 dB contour is predicted to increase due to higher use of Runway 9 for departures. For Boston, the number of people within both the DNL 70 dB and DNL 65 dB contours is expected to increase in the Orient Heights neighborhood due to higher use of Runway 22L for arrivals and Runway 4R for departures. In East Boston and the Eagle Hill neighborhood, as for Chelsea, the population within DNL 65 dB is expected to decrease as a result of fewer Runway 15R arrivals and decreased Runway 33L departures.

28 The 2010, 2017 and Future Planning Horizon population counts are based on 2010 U.S. Census data. The 2000 counts are based on 2000 U.S. Census data and the 1990 counts are based on 1980 U.S. Census data.

Table 6-18 Future Planning Horizon Noise-Exposed Population by Community Compared to 2017 and Historical Levels

Boston

Year	80+ DNL	75-80 DNL	70-75 DNL	65-70[1] DNL	Total (65+)
1990[3]	0	0	1,778	28,970	30,748
2000[3]	0	0	234	9,014[2]	9,248[2]
2010[3]	0	0	0	689[2]	689[2]
2017[4]	0	0	14	4,720	4,734
Forecast[4]	0	0	17	4,027	4,044

Revere

Year	80+ DNL	75-80 DNL	70-75 DNL	65-70[1] DNL	Total (65+)
1990[3]	0	0	0	4,274	4,274
2000[3]	0	0	0	2,496	2,496
2010[3]	0	0	0	2,413	2,413
2017[4]	0	0	0	2,362	2,362
Forecast[4]	0	0	0	3,040	3,040

Chelsea

Year	80+ DNL	75-80 DNL	70-75 DNL	65-70[1] DNL	Total (65+)
1990[3]	0	0	0	4,813	4,813
2000[3]	0	0	0	0	0
2010[3]	0	0	0	0	0
2017[4]	0	0	0	65	65
Forecast[4]	0	0	0	0	0

Winthrop

Year	80+ DNL	75-80 DNL	70-75 DNL	65-70[1] DNL	Total (65+)
1990[3]	0	676	1,211	2,420	4,307
2000[3]	0	247	1,070	4,684	6,001
2010[3]	0	0	130	598	728
2017[4]	0	0	125	647	772
Forecast[4]	0	0	202	1,070	1,272

Everett

Year	80+ DNL	75-80 DNL	70-75 DNL	65-70[1] DNL	Total (65+)
1990[3]	0	0	0	0	0
2000[3]	0	0	0	0	0
2010[3]	0	0	0	0	0
2017[4]	0	0	0	0	0
Forecast[4]	0	0	0	0	0

All Communities

Year	80+ DNL	75-80 DNL	70-75 DNL	65-70[1] DNL	Total (65+)
1990[3]	0	676	2,989	40,477	44,142
2000[3]	0	247	1,304	16,194[2]	17,745[2]
2010[3]	0	0	130	3,700[2]	3,830[2]
2017[4]	0	0	139	7,794	7,933
Forecast[4]	0	0	219	8,137	8,356

Source: HMMH.

Notes: The 1990 population estimates are based on the 1980 U.S. Census data; 2000 population estimates are based on the 2000 U.S. Census data; and 2010, 2017, and Future Planning Horizon population estimates are based on the 2010 U.S. Census data.

1 Day-Night Average Sound Level (DNL) 65 decibel (dB) is the federally-defined noise criterion used as a guideline to identify when residential land use is considered incompatible with aircraft noise.

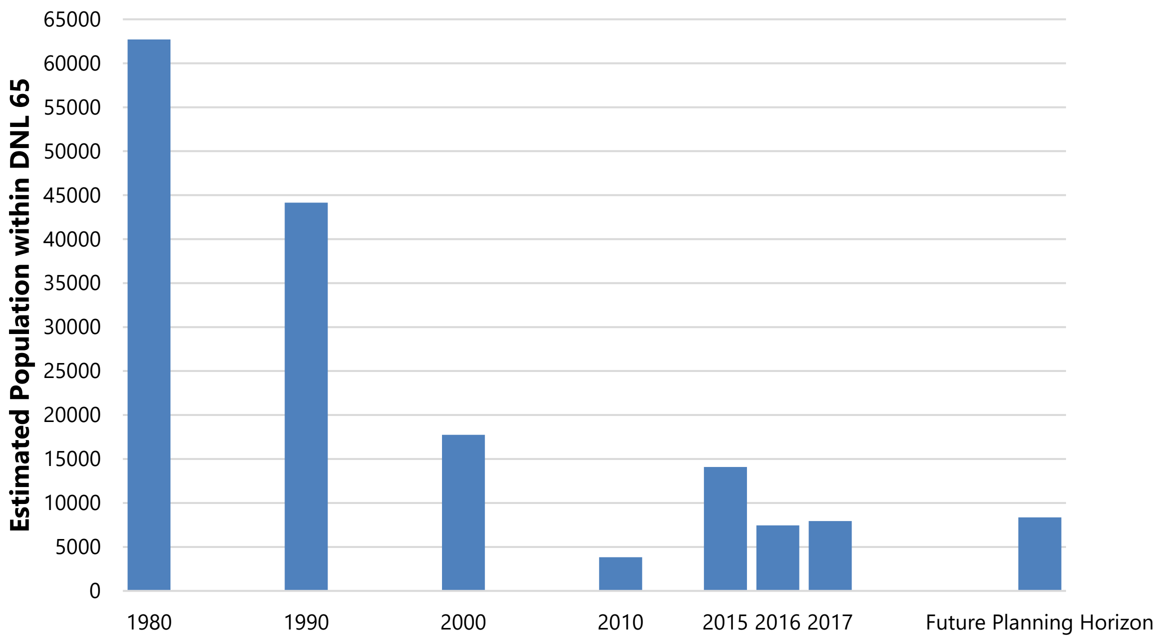
2 These values reflect the effect of the Federal Aviation Administration (FAA)-approved terrain adjustment in Orient Heights.

3 Noise modeled INM.

4 Noise modeled with AEDT.

Figure 6-19 shows the long-term trend in population exposed to levels equal to or higher than DNL 65 dB since 1980.

Figure 6-19 DNL 65 dB Exposed Population Trend



Source: Massport and HMMH, 2018.

Noise Per Seat Index (NPSI)

In the 1990s, Massport developed a metric termed the Noise Per Seat Index (NPSI), which was designed to encourage the reduction of Stage 2 commercial jet aircraft in use at the Airport. The index level was set and then lowered each year. To reach the new level, airlines would switch to newer Stage 3 aircraft on their routes. The index was last set in 1998 because the federal government mandated the phase out of Stage 2 aircraft greater than 75,000 pounds by December 31, 1999. The FAA Reauthorization bill, passed in early 2012, also mandated the phase out of Stage 2 aircraft with a takeoff weight less than 75,000 pounds by 2015.

The index provided a dB noise level per seat, computed by using the number of operations, the number of seats per aircraft, and the certificated noise levels for takeoffs and landings for each aircraft type. For comparison purposes, using this same method, Massport computed the NPSI value for all commercial jet operations for 2000, 2011, 2017 and the Future Planning Horizon forecast. These results are shown in **Table 6-19**.

Table 6-19 Noise Per Seat Index (NPSI)

Year	Jet Operations	Average Number of Seats per Aircraft	NPSI (dB EPNL)
2000	306,026	161.7	73.4
2011	283,320	133.1	72.0
2017	325,926	163.0	71.3
Future Planning Horizon	409,599	165.5	71.5

Source: HMMH.

The NPSI analysis shows that in the Future Planning Horizon scenario, even with a higher number of commercial jet operations, the forecast NPSI would be comparable to the 2017 value because of the higher average number of seats per aircraft combined with the quieter new technology aircraft. Efficiency, in the form of larger, quieter aircraft carrying more passengers, equates to lower noise-per-seat values. As shown in **Table 6-19**, the average number of seats decreased to 133.1 in 2011, primarily due to the use of RJs and smaller narrow-body aircraft on routes as compared to 2000. This number increased in recent years, and continues to follow that trend in the forecast year with the average number of seats at 163.0 in 2017 and 165.5 in the Future Planning Horizon. The NPSI continues to decline from 73.4 dB in 2000 to 71.3 in 2017 and 71.5 dB by the forecast year.

Historical Context and Trends

Logan Airport has demonstrated a long-term trend of noise level reduction due to efforts by Massport, the FAA, and improvements in engine technologies such as the nationwide phaseout of Stage 2 operations in 1999 and today's requirements that newly certificated aircraft meet Stage 5 noise levels. **Figure 6-20** presents the DNL 65 dB noise contours from 1990, 2017, and the Future Planning Horizon. For 1990 and 2017, the contours are from actual operations data. The predicted contours for the Future Planning Horizon are based on forecast data prepared for this *2017 ESPR*.

The most important changes in the Logan Airport noise environment, visible in **Figure 6-20**, are the obvious decreases in noise levels, largely attributable to modernization of aircraft fleets. As shown in **Table 6-20**, the 1990 contour reflected a mix of aircraft operations where almost 50 percent of the jets in the fleet were Stage 2 types and over 40 percent of the overall fleet were non-jet aircraft. The contour also reflects the prior Runway 27 departure procedure, as the current FAA procedure was implemented in 1996.

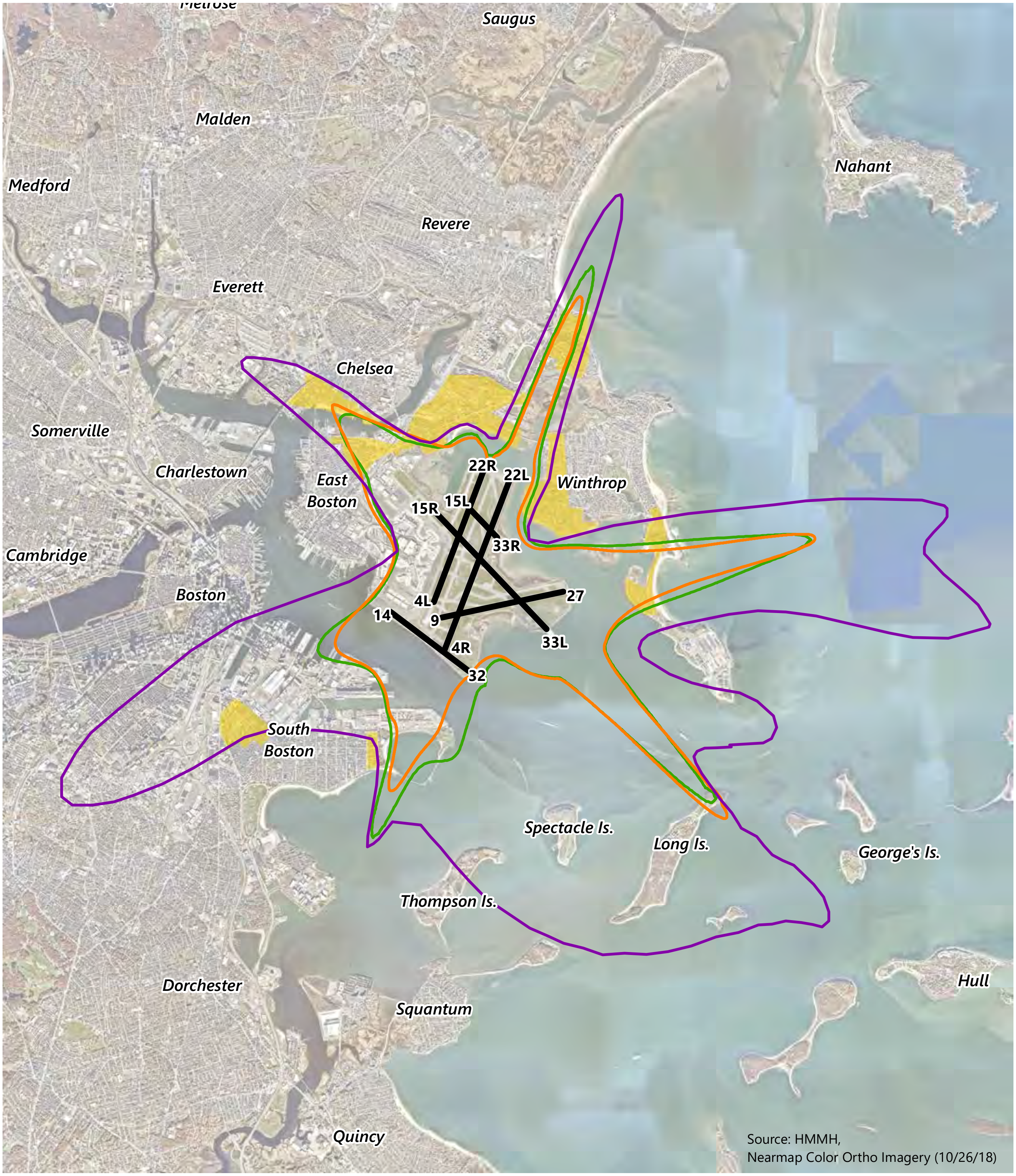


FIGURE 6-20 Comparison of Historical and Forecast DNL 65 dB Contours – 1990, 2017, Future Planning Horizon

2017 Environmental Status and Planning Report

1990 DNL Contour (INM)
2017 DNL Contour (AEDT 2d)
Future Planning Horizon DNL Contour (AEDT 2d)
Sound Insulation Areas

0 2500 5000 10000 Feet

Table 6-20 Modeled Average Daily Operations by Commercial and General Aviation (GA) Aircraft

		1990	2017	Future Planning Horizon[1]
Commercial Aircraft				
Stage 2 Jets[2]	Day	312.40	0.00	0.00
	Night	19.99	0.00	0.00
	Total	332.39	0.00	0.00
Stage 3 or Higher Jets (All)	Day	288.89	734.46	963.63
	Night	57.25	158.49	158.56
	Total	346.14	892.95	1,122.19
Non-Jet Aircraft	Day	444.41	119.03	120.90
	Night	11.72	2.24	2.61
	Total	456.13	121.27	123.51
Total Commercial Operations	Day	1,045.70	853.49	1,084.52
	Night	88.96	160.73	161.17
	Total	1,134.66	1,014.22	1,245.69
GA Aircraft				
Total GA Operations	Day	**N/A[2]**	78.61	80.23
	Night	**N/A[2]**	6.81	6.58
	Total	**N/A[2]**	**85.43**	**86.81**
Total	Day	1,045.70	932.10	1,164.75
	Night	88.96	167.54	167.75
	Total	**1,134.66**	**1,099.65**	**1,332.50**

Source: HMMH.
Notes: Totals prior to 1998 do not include GA operations.
N/A Not available.
1 Predicted.

Noise Abatement Efforts

Massport's noise abatement program continues to play a critical role in helping to limit and monitor noise impacts. Massport's emphasis on noise abatement has focused on the benefits of better analysis tools, involvement in noise research projects and improved modeling techniques to identify the causes of noise problems. Massport also continues to coordinate with FAA and the Massport CAC on matters related to runway use and the ongoing RNAV Pilot project.

Massport's NOMS, installed in 2008, includes extensive analysis and mapping capabilities, the latest FAA NextGen radar data feed, use of multilateration radar (a separate and unique source of operational data), improved noise complaint handling, and direct correlation of noise events with radar flight paths and complaints (a feature that the prior system did not have). This latter capability has improved the ability of the system to differentiate between aircraft and community noise sources. All measured data and complaint information in this report were generated through the NOMS. Massport recently evaluated the current system and went out to bid for an upgraded NOMS in 2018.

Other continuing elements of Massport's noise mitigation program are discussed below.

Residential Sound Insulation Program

- In accordance with FAA requirements, Massport has one of the most extensive residential and school sound insulation programs in the nation. To date, Massport has installed sound insulation in 5,467 residences, including 11,515 dwelling units, and 36 schools in East Boston, Roxbury, Dorchester, Winthrop, Revere, Chelsea, and South Boston. Historically, the percentage of eligible homeowners who have responded and whose dwellings are ultimately treated varies significantly by community from a high of nearly 90 percent in Revere to a low of about 50 percent in South Boston. Approximately 80 to 85 percent of homeowners in East Boston and Winthrop have historically participated. Approximately 8 percent of applicants also choose the Room-of-Preference option that allows the owner to identify a room (usually a bedroom or living room) for extra acoustical treatment.
- The noise mitigation program includes operational restrictions on certain runways, limits to engine runup locations, late night runway preference, and noise abatement turns. Eligibility for sound insulation must follow FAA guidelines which state that the residence must be located within the latest DNL 65 dB contour submitted to the FAA and a noncompatible structure must be experiencing existing interior noise levels within habitable rooms that are 45 dB or greater with the windows closed to be considered eligible.[29] Also, structures constructed after October 1, 1998 are not eligible and structures that do not meet building codes are not eligible until the building's deficiencies have been addressed. The FAA will allow a residence to be treated under the sound insulation program one time; homes treated previously are not eligible for additional consideration.[30]

29 FAA Airport Improvement Handbook, Appendix R.

30 FAA Airport Improvement Handbook, Table C-5 Item (8), page C-19.

- Massport will continue to work with the FAA to sound insulate eligible homes. Massport will apply for FAA funds to treat eligible properties, as needed. As of 2015, the FAA requires airports to use the AEDT model to establish eligibility; therefore, Massport intends to submit an AEDT-derived noise exposure map to be kept on file with the FAA. The FAA has requested that the updated sound insulation program contour represent 2019 operational conditions. At the time of this publication, Massport is in the process of producing this updated noise exposure map.
- The Massport Noise Abatement Office was initiated in 1977 and maintains the noise section of the Massport website.[31] The website provides information on Massport's sound insulation program, the Airport's noise monitoring system, various abatement measures, and other information of interest to the public.

Other Massport Noise Initiatives

- Massport develops annual noise contours (**Figure 6-13** compares the DNL 65 dB contours for 2016 AEDT 2cSP2 and 2017 AEDT 2d and **Figure 6-18** shows the future, anticipated contour for the Future Planning Horizon).
- Massport's website features an internet flight tracking system known as PublicVue.[32] The PublicVue site allows the user to view flight tracks in near-real time, replay flight tracks, and enter noise complaints.
- The Noise Office uses summary reports of operations by airline, runway, aircraft type, and other parameters to help track potential changes in the noise environment. **Tables 6-12** and **6-14** are examples of these reports.
- Massport, in an advisory role, participated in the completed FAA BLANS process, which designed RNAV departure procedures off most runways to avoid highly populated areas and the use of an over-water visual approach at night to keep aircraft offshore as much as possible.
- Massport supports, where possible, the Massport CAC. The Massport CAC is a state-legislated body that works with Massport on a range of Authority-wide topics, including environmental issues. Further information about the Massport CAC can be found at http://massportcac.org/.
- Massport supported FAA RNAV initiatives to develop RNAV arrivals and the Runway 33L departure RNAV procedure.
- Massport annually contacts airlines to encourage the use of single engine taxiing whenever possible.
- Massport strives to participate in research to reduce community noise levels whether through the Airport Cooperative Research Program (ACRP) or with FAA, such as the RNAV Pilot project currently underway.

31 Logan Airport Noise Abatement Website. http://www.massport.com/logan-airport/about-logan/noise-abatement/.
32 Massport. *Flight Monitor*. http://www.massport.com/logan-airport/about-logan/noise-abatement/flight-monitor/.

Airline Fleet Improvements

Commercial air carrier and cargo operators are deploying the newest engine technology at Logan Airport. **Table 6-21** reports the percent of an airline's fleet that is Stage 3 or Stage 4 equivalent for 2016, and Stage 3, Stage 4 equivalent, or Stage 5 equivalent for 2017. The majority of major U.S. airlines at Logan Airport are using a fleet composed of 100 percent originally manufactured Stage 3 or Stage 4 aircraft. All new carriers at Logan Airport in 2016 and 2017 are using Stage 4 or Stage 5 equivalent aircraft. The new FAA Stage 5 requirements are already satisfied by 18 percent of jet operations for 2016 and 2017.

Massport recently completed terminal and airfield improvements designed to safely handle the next generation of larger and more efficient FAA Design Group VI[33] aircraft. Use of the larger aircraft such as the 747-800, 787, or the A380 will help to continue the trend of carrying more passengers in fewer flights.

Table 6-21 Airline Operations Percentages in Original Stage 3 or Equivalent Stage 4/5 Aircraft (2016 to 2017)

Airlines with more than 100 flights	Number of Flights[1]		Percentage of Stage 3 or Equivalent Stage 4 or 5 Operations[2]				
	2016	2017	2016 Stage 3	2016 Stage 4[3]	2017 Stage 3	2017 Stage 4	2017 Stage 5
jetBlue Airways	91,736	100,892	0%	100%	0%	94%	6%
American Airlines	55,782	51,296	0%	100%	1%	85%	14%
Delta Air Lines	33,935	35,921	7%	93%	5%	75%	20%
United Airlines	25,052	24,636	0%	100%	0%	76%	24%
Southwest Airlines	24,436	24,129	18%	82%	13%	86%	1%
Republic Airlines	1,458	11,994	0%	100%	2%	98%	0%
Spirit Airlines	7,245	8,853	0%	100%	0%	8%	92%
Endeavor Air	1,377	7,977	0%	100%	0%	92%	8%
Jazz Air Inc.	5,832	5,947	0%	100%	0%	15%	85%
Air Canada	2,713	3,947	0%	100%	0%	100%	0%
FedEx	3,896	3,755	64%	36%	15%	84%	0%
Virgin America	3,724	3,754	0%	100%	1%	97%	1%
Air Wisconsin	5,010	3,727	0%	100%	0%	0%	100%
ExpressJet	4,032	3,660	0%	100%	0%	42%	58%
Alaska Airlines	3,256	3,351	0%	100%	0%	100%	0%

33 FAA categorizes aircraft by size for airport design purposes. Design Group VI is the largest size and includes the A380 and B747-8.

Table 6-21	Airline Operations Percentages in Original Stage 3 or Equivalent Stage 4/5 Aircraft[1] (2016 to 2017) (Continued)						
Airlines with more than 100 flights	**Number of Flights[1]**		**Percentage of Stage 3 or Equivalent Stage 4 or 5 Operations[2]**				
	2016	**2017**	**2016 Stage 3**	**2016 Stage 4[3]**	**2017 Stage 3**	**2017 Stage 4**	**2017 Stage 5**
GoJet Airlines	2,783	3,136	0%	100%	0%	100%	0%
British Airways	2,702	2,522	0%	100%	0%	50%	50%
United Parcel Service	1,834	2,053	0%	100%	0%	89%	11%
Aer Lingus	2,066	2,011	1%	99%	0%	100%	0%
Lufthansa	1,728	1,707	0%	100%	0%	0%	100%
Sky Regional Airlines Inc	2,738	1,470	0%	100%	0%	100%	0%
MN Airlines, LLC	1,374	1,391	0%	100%	0%	100%	0%
Icelandair	1,358	1,265	0%	100%	38%	1%	61%
Emirates Airlines	1,382	1,034	0%	100%	0%	97%	3%
Hainan Airlines Co. Ltd.	961	1,032	0%	100%	0%	0%	100%
Swiss Air	1,020	924	0%	100%	0%	0%	100%
Air France	900	884	0%	100%	0%	32%	68%
SATA International Airlines	630	844	0%	100%	0%	89%	11%
Norwegian Air Shuttle	656	767	0%	100%	0%	14%	86%
Virgin Atlantic	715	764	0%	100%	0%	0%	100%
Japan Airlines	736	730	0%	100%	0%	0%	100%
Compañía Panameña de Aviación S.A.	638	730	0%	100%	0%	100%	0%
Piedmont Airlines	NA	729	N/A	N/A	0%	0%	100%
Qatar Airways	552	728	0%	100%	0%	0%	100%
WOW Air, LLC.	678	724	0%	100%	98%	2%	0%
Aeromexico	580	667	0%	100%	0%	100%	0%
Cathay Pacific	454	652	0%	100%	0%	100%	0%
TAP - Air Portugal	378	643	0%	100%	0%	100%	0%
Turkish Airlines	658	616	0%	100%	0%	0%	100%
Alitalia	558	548	0%	100%	0%	99%	1%

Table 6-21 Airline Operations Percentages in Original Stage 3 or Equivalent Stage 4/5 Aircraft[1] (2016 to 2017) (Continued)

Airlines with more than 100 flights	Number of Flights[1]		Percentage of Stage 3 or Equivalent Stage 4 or 5 Operations[2]				
	2016	2017	2016 Stage 3	2016 Stage 4[3]	2017 Stage 3	2017 Stage 4	2017 Stage 5
Scandinavian Airlines of North America, Inc.	500	536	0%	100%	0%	94%	6%
Iberia Air Lines of Spain	412	464	0%	100%	0%	97%	3%
Shuttle America Corp	6,546	418	0%	100%	6%	94%	0%
Mesa Airlines	486	327	0%	100%	28%	72%	0%
Pinnacle Airlines	6,260	N/A	0%	100%	N/A	N/A	N/A
SkyWest Airlines	108	N/A	0%	100%	N/A	N/A	N/A
ATI	502	326	0%	100%	0%	96%	4%
El Al Israel Airlines Ltd.	296	298	100%	0%	42%	58%	0%
Air Berlin	192	278	0%	100%	0%	100%	0%
Avianca	N/A	226	N/A	N/A	0%	100%	0%
Thomas Cook Airlines	N/A	154	N/A	N/A	0%	1%	99%
Atlas Air	N/A	136	N/A	N/A	100%	0%	0%

Source: Massport, 2018.
N/A Not available.
1 Operations for some carriers differ with those in Chapter 2, *Activity Levels*, and Chapter 7, *Air Quality/Emissions Reduction,* because the table only includes jet aircraft, not turboprops, and it includes both scheduled and unscheduled air carriers.
2 Original Stage 3 means originally manufactured as a certificated Stage 3 aircraft under FAR Part 36. Stage 4 equivalent or Stage 5 equivalent means the aircraft meets Stage 4 or Stage 5 requirements, even if it is not certificated as such.
3 Stage 5 equivalence data was not collected by airline for 2016.

Noise Complaint Line

In 2017, Massport received 59,343 noise complaints from 95 communities, a 56-percent increase from the 2016 total of 38,045 noise complaints from 83 communities. The community of Medford generated over 28 percent of this increase and has the most unique callers; the community of Milton continues to log the highest number of complaints. The number of individual complainants increased by 89 percent from 2016 to 2017, from 2,260 callers[34] in 2016 to 4,269 callers in 2017.

Recent technological advances in both Massport's noise complaint phone system and online complaint tracking system, as well as the incorporation of third-party complaint applications, have made it easier for community members to file a complaint and to receive information about particular noise events. In 2016, the average number of complaints per individual caller (the ratio of calls to callers) was 16.8. In 2017, this ratio decreased to an average 13.9 complaints per caller.

Table 6-22 is a summary of noise complaints from the Massport Noise Abatement Office. The summary table presents the fifteen communities with the greatest number of complaints for 2017, along with the number of callers and the corresponding numbers from 2016. The communities listed below represent 91 percent of the complaints in 2017 and 90 percent of the complaints in 2016. All remaining communities are summed together into a single line above the grand total. Appendix H, *Noise Abatement,* has a full listing of the complaints by community.

34 The term "caller" here also includes online noise complaint system users.

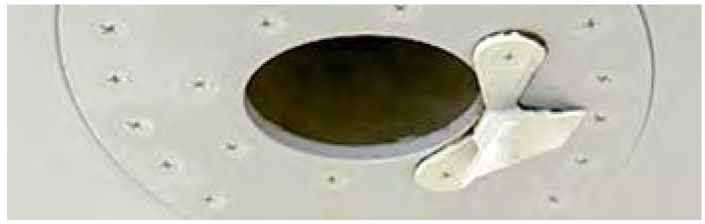
Table 6-22 Noise Complaint Line Summary

Town	2016		2017		Change in Calls (2016 to 2017)
	Calls	Callers	Calls	Callers	
Arlington	1,968	87	2,252	137	284
Belmont	501	63	1,129	102	628
Cambridge	2,154	128	1,657	211	-497
Hull	1,266	220	1,500	175	234
Jamaica Plain	434	76	2,016	274	1,582
Malden	10	7	1,987	96	1,977
Medford	1,784	177	7,856	745	6,072
Milton	21,796	466	23,940	486	2,144
Roslindale	588	103	2,094	203	1,506
Roxbury	286	40	891	36	605
Somerville	1,804	153	3,762	309	1,958
South Boston	577	42	1,792	78	1,215
Watertown	265	38	818	65	553
West Roxbury	170	21	1,104	56	934
Winchester	489	16	895	111	406
Total (for towns listed above)	**34,092**	**1,637**	**53,693**	**3,084**	**19,601**
Total Complaints from Other Towns	3,953	623	5,650	1,185	1,697
Overall Totals	**38,045**	**2,260**	**59,343**	**4,269**	**21,298**

Source: Massport, 2019.
Notes: Changes in ( ) represent a decrease in noise complaints.
Only the top fifteen communities for each year are listed above. The complete list of complaints is in Appendix H, *Noise Abatement*.

Airbus A320 Vortex Generators

Figure 6-21 Vortex Generator Device by Port on Wing



Massport encourages operators to use idle or reduced reserve thrust during landing, and to retrofit the Airbus A319/320/321 family of aircraft with vortex generators, which reduce tonal noise on approach. A vortex generator is a small device that disrupts wind over ports on the wing. Without the device, the wind can produce a "whistling" tone during the aircraft's approach into an airport. These actions are detailed in a letter included in Appendix L, *Reduced/Single Engine Taxiing at Logan Airport Memoranda*, which Massport issued to air carriers at Logan Airport. All Airbus A319/320/321 built after 2014 already come equipped with the Vortex Generator. United Airlines announced it was retrofitting its aircraft in 2017 as they went in for service. In a press release in October 2018, jetBlue Airways (the largest air carrier operator at Logan Airport) announced plans to retrofit its older Airbus fleet with Vortex Generators (see **Figure 6-21** for an example of this). These changes reflect the partnership between Massport and the airlines to reduce aircraft noise to benefit surrounding communities. As airlines retrofit aircraft and transition to the newer models of the A320 family, the number of aircraft operating at Logan Airport without the vortex generators is expected to decrease. Please see the attached press release earlier in this chapter.

FAA and Massport RNAV Pilot Project

Over the last several years, the implementation of new PBN procedures – including RNAV – has resulted in a concentration of flights. On October 7, 2016, FAA signed a Memorandum of Understanding (MOU) with Massport[35] to frame the process for analyzing opportunities to reduce noise through changes or amendments to PBN. Massport has been working with FAA and others to develop test projects that are designed to help address the concentration of noise from PBN. To more clearly understand the implications of flight concentration, Massport has proposed several ideas for a test program with FAA; this program will study possible strategies to address neighborhood concerns. FAA has agreed to study Massport's ideas for a test program. This is a first-in-the-nation project between FAA and an airport operator that includes analyzing the feasibility of changes to some RNAV approaches and departures from Logan Airport. FAA and Massport are committing to: (1) analyze the feasibility; (2) measure and model the benefits and impacts of changing some RNAV approaches; and (3) test and develop an implementation plan, which will include environmental analysis and community/public outreach.

35 Massport. October 7, 2016. *Massport and FAA Work to Reduce Overflight Noise.* https://www.massport.com/news-room/news/massport-and-faa-work-to-reduce-overflight-noise/.

The preliminary areas of study could include:

- Using higher altitudes for arrivals, where applicable;
- Using higher altitudes for departures, where applicable;
- Determining the feasibility of reducing the persistent level of noise from RNAV departures through a case study analysis of a major departure procedure from Runway 33L;
- Studying RNAV separation requirements – currently departure and arrival procedures require a separation of 3 miles for head-to-head operations;
- Analyzing alternative RNAV designs that would bring aircraft over more compatible land use; and
- Using real-world single-event noise data from communities under RNAV tracks to develop a supplemental metric to measure and track the concentration of flights due to RNAV technology. These metrics would improve data collection for communities and FAA and would better identify the community support for, or opposition to, proposed procedural changes. The proposed pilot testing will use these supplemental metrics.

The project has been structured in two phases, or “blocks”. Block 1 recommendations are those that would not result in shifting noise from one area to another, and that would not have significant operational/technical implications. Block 2 recommendations could result in noise increases in some areas or face technical barriers that would require further review. An early outcome of the Block 1 process was the development of an RNAV visual approach to Runway 33L. This approach would be similar to the jetBlue Airways RNAV visual to Runway 33L already in place but would be a published procedure for all airlines to use. A copy of the Massport request to FAA from April 2017 is included in Appendix H, *Noise Abatement*. Since the letter was sent, FAA and Massport have further refined the procedure and FAA is evaluating its implementation.

A report on Block 1 recommendations was completed in December 2017, and the Massport CAC voted to approve and recommend implementation of the Block 1 procedures. On December 20, 2017, Massport sent a request for FAA review and implementation of the Block 1 recommendations. A copy of the letter is provided in Appendix H, *Noise Abatement*. FAA review of Block 1 recommendations began in 2018 and is ongoing. The RNAV technical team, led by MIT, is currently working on Block 2 and has provided updates to the Massport CAC on its progress.

Reduced Engine Taxiing

Single or reduced engine taxiing has the potential to reduce noise at Logan Airport. When used, the largest benefit is achieved by reducing the use of the engines on the side of the aircraft closest to the community. However, this is not always practicable due to airline procedures, taxiway routings, and safety considerations. Massport has reached out to the airlines and encouraged the use of this procedure whenever practicable. The letter sent to airport users for 2017 from Massport is published in Appendix L, *Reduced/Single Engine Taxiing at Logan Airport Memoranda*.

In 2009, MIT, in cooperation with Massport and the FAA, conducted a survey of pilots at Logan Airport and found that the procedure was widely used on arrivals but not frequently used on departures.[36] Key reasons cited for not using the procedure were safety-related or practical reasons such as a short taxi time. The survey indicated that for the procedure to be considered for arrivals, the taxi-in time would have to exceed 10 minutes and for departures, exceed 20 minutes. The average taxi-out times for Logan Airport for 2017 exceeded 20 minutes only during the 6:00 to 8:00 AM and 5:00 and 9:00 PM periods, and for 2016 they exceeded 20 minutes only during the 5:00 to 6:00 PM and the 7:00 to 8:00 PM periods. During 2016 and 2017, the average taxi-in time never exceeded 10 minutes. The average taxi-out time at Logan Airport for 2017 increased to 19.1 minutes from 18.1 minutes in 2016. The average taxi-in time increased to 7.5 minutes from 7.2 minutes. Overall, the average taxi/delay time for 2017 increased to 13.3 minutes from 12.8 minutes in 2016.[37] These small changes year to year occur due to several factors such as changes in schedules, weather, and use of the runways. Mandatory single engine taxiing was also one of the proposed measures in the BLANS but was rejected by FAA due to safety concerns.

Boston Logan Airport Noise Study (BLANS)

FAA's Record of Decision (ROD) approving construction of the unidirectional Runway 14-32 required that FAA, Massport, and the Logan Airport CAC jointly undertake a study, known as the BLANS, to determine whether changes to existing noise abatement flight track corridors might further reduce noise impacts. In addition, the Massachusetts Environmental Policy Act (MEPA) Certificate for the *Boston Logan Airside Improvements Planning Environmental Impact Report (EIR)* directed Massport to work with FAA and local communities on a review of the Logan Airport PRAS. FAA has been implementing RNAV procedures at airports across the country and those noise studies were able to influence the design of the RNAV procedures for implementation at Logan Airport. The BLANS consisted of three phases that concluded in 2017. The Logan Airport CAC could not agree on a runway use program from Phase 3 to recommend. Therefore, the study ended without a recommendation, and a final report on the BLANS program was issued in April 2017.

36 The full report was published in the *2009 EDR* in Appendix L, *Survey of Airline Pilots Regarding Fuel Conservation Procedures for Taxi Operations*.

37 Federal Aviation Administration (FAA) Aviation System Performance Metrics: Avg. Taxi Time: Standard Report.

Noise Abatement Management Plan

Massport's noise abatement goals are achieved through the implementation of multiple elements. **Table 6-23** lists these goals and the associated plan elements and reports on progress toward achieving these goals.

Table 6-23 Noise Abatement Management Plan

Noise Abatement Goal	Plan Elements	2017 Progress Report
Limit total aircraft noise	Limit on Cumulative Noise Index (CNI)	The CNI value for 2017 was 153.1 EPNdB which is well below the cap of 156.5 EPNdB.
	Stage 3 percentage Requirement in Noise Rules	In 2017, 100 percent of Logan Airport's total commercial jet traffic satisfied Stage 3 noise criteria or better. The newest Stage 5 category comprised 18 percent of these operations.
Mitigate noise impacts	Residential Sound Insulation Program (RSIP)	No additional dwelling units were sound insulated in 2017, leaving the total of treated dwelling units at 11,515 since the start of the program in 1986. See Appendix H, *Noise Abatement,* for additional details.
	School Sound Insulation Program	Thirty-six eligible schools have been sound insulated since this program began.
	Noise Abatement Arrival and Departure Procedures	Flight track monitoring and data analysis were used to verify adherence to noise abatement flight procedures. See Appendix H, *Noise Abatement,* for data from the 2016 and 2017 Monitoring Reports.
	Preferential Runway Advisory System (PRAS) Runway End Use Goals	Massport continues to report on runway use compared to PRAS goals.
	Runway Restrictions	Noise-based use restrictions 24 hours per day on departures from Runway 4L and arrivals on Runway 22R were continued.
	Reduced-Engine Taxiing	Voluntary use of reduced-engine taxiing is encouraged when appropriate and safe. See Appendix L, *Reduced/Single Engine Taxiing at Logan Airport Memoranda,* for information.
Continue to Improve the Noise Monitoring System	Evaluate current system and update system as needed	In 2018, Massport did a thorough review of its current noise monitoring system and went out to bid for an upgraded system.
Minimize nighttime noise	Nighttime Stage 2 Aircraft Prohibition	With the Federal Aviation Administration's (FAA's) ban on all Stage 2 operations after December 31, 2015, this prohibition is no longer necessary.
	Nighttime Runway Restrictions	Prohibitions on use of Runway 4L for departures and Runway 22R for arrivals between 11:00 PM and 6:00 AM were continued.
	Maximization of Late-Night Over-Water Operation	Efforts to maximize late-night over-water operations were continued. Use of Runway 15R for departures and Runway 33L for arrivals continued.

Table 6-23 Noise Abatement Management Plan (Continued)

Noise Abatement Goal	Plan Elements	2017 Progress Report
Minimize nighttime noise (continued)	Nighttime Engine Run-up and auxiliary power unit (APU) Restrictions	Restriction on nighttime engine run-ups and use of APUs was continued.
Address/respond to noise issues and complaints	Noise Complaint Line	Massport continued operation of its Noise Complaint Line, (617) 561-3333.
	Special Studies	Massport continued to provide technical assistance and analysis using noise monitoring system to support the FAA and others in monitoring jet departure tracks from Runway 27 and Runway 33L. Massport and the FAA are conducting an RNAV evaluation project designed to identify ways to reduce noise from the RNAV procedure (which concentrates flights).

Source: Massport.

7

Air Quality/Emissions Reduction

Key Findings

- The Massachusetts Port Authority's (Massport's) air quality management strategy for Boston Logan International Airport (Logan Airport or the Airport) focuses on decreasing emissions from Airport-related sources. Key Massport initiatives to reduce air emissions from Airport operations include:
  - Replacement of gas- and diesel-powered ground service equipment (GSE) with electric equivalents by the end of 2027, where commercially available;
  - Commitment to Leadership in Energy and Environmental Design (LEED®) and other sustainable building standards;
  - Investment in renewable energy installations on-Airport (solar/wind);
  - Use of clean-fuel shuttle buses; and
  - Implementation of extensive strategies to promote high occupancy vehicle (HOV) use and ground transportation improvements.
- Total modeled emissions of carbon monoxide (CO), particulate matter ($PM_{10}/PM_{2.5}$), and volatile organic compounds (VOCs) have decreased from 2016 to 2017 by about 4 percent, 20 percent, and less than 1 percent, respectively, even though aircraft operations have increased over the same time period. In the Future Planning Horizon, which assumes 50 million annual air passengers and approximately 486,000 aircraft operations in the next 10 to 15 years, total emissions of CO, $PM_{10}/PM_{2.5}$, and VOCs are predicted to decrease further by about 2 percent, 10 percent, and 8 percent, respectively, compared to 2017 levels. The projected reduction in emissions is due to a combination of the conversion of GSE to viable electric alternatives, lower motor vehicle emissions due to greater efficiency, cleaner aircraft engine technologies, and changes in aircraft fleet mix.
- Total emissions of oxides of nitrogen (NO_x) increased by about 12 percent from 2016 to 2017. This increase in NO_x is almost entirely attributed to the changing aircraft fleet (i.e., greater use of quieter, more fuel-efficient aircraft engines that overall result in fewer emissions with the exception of NO_x) coupled with the forecasted increase in aircraft operations at the Airport. Emissions of NO_x are predicted to increase by about 37 percent in the Future Planning Horizon compared to 2017. The changes are also also attributable to the Federal Aviation Administration's (FAA's) Aviation Environmental Design Tool (AEDT) model, which assumes higher NO_x emission factors compared to the legacy Emissions and Dispersion Modeling System (EDMS) model. NO_x emissions associated with GSE, motor vehicles, and stationary sources, many of which Massport has control or influence, have declined.
- Greenhouse gas (GHG) emissions increased from 2016 to 2017 by about 8 percent due primarily to the increase in aircraft operations. Total Logan Airport GHG emissions, however, remained less than 1 percent of statewide emissions in 2017. Total emissions of GHG in the Future Planning Horizon are predicted to be about 23 percent higher than 2017 levels predominantly due to the predicted increase in aircraft operations.

Introduction

Massport is a national leader in studying, tracking, and reporting on the air quality environment of Logan Airport, and in implementing measures to reduce emissions. Recognized as early as 2008 with an environmental award for Logan Airport's Emissions Reduction Program, Massport annually prepares an inventory of Airport-related emissions of the U.S. Environmental Protection Agency (EPA) criteria pollutants (and their precursors) including CO, NO_x, PM,[1] and VOCs. An emissions inventory of GHGs is also included.

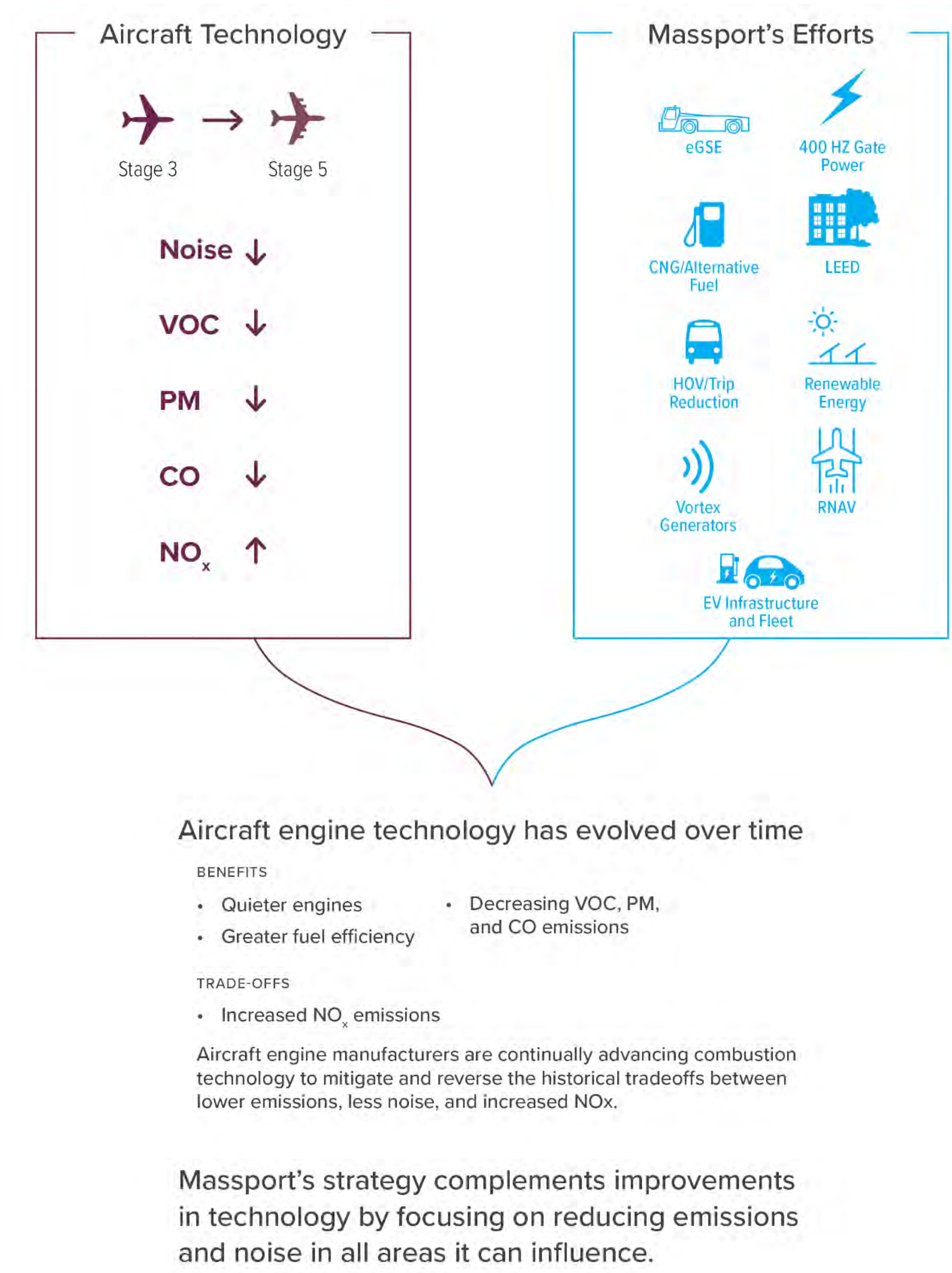
As reported in previous Environmental Data Reports (EDRs) and Environmental Status and Planning Reports (ESPRs), total emissions from all sources associated with Logan Airport are less than they were a decade ago, with the exception of NO_x. This long-term downward trend is consistent with Massport's longstanding objective to accommodate the demands of increasing passenger and cargo activity levels with fewer aircraft operations and reduced emissions. When compared to 2016, the changes in air emissions in 2017 are well within expected values given the corresponding upturn in aircraft operations.

The majority of NO_x emissions from aircraft originate from high-temperature, high-pressure reactions of atmospheric nitrogen in aircraft engines. Over time, aircraft engine technology has evolved to be more fuel-efficient, less polluting, and quieter, in large part due to improved fuel combustion under these higher temperature and pressure conditions. This interdependency (or trade-off) between increased NO_x, less noise, better fuel efficiency, and lower emissions for other pollutants (including carbon dioxide [CO_2]), is an inevitable outcome of the modernization of the commercial air carrier fleet. Aircraft engine manufacturers are continually advancing combustion technology that is designed to mitigate and reverse the historical tradeoffs between less noise, lower emissions, and increased NO_x (**Figure 7-1**). This trend is likely to continue in the future. NO_x emissions at Logan Airport in 2017 represent only about 2 percent of Massachusetts NO_x emissions.

Since Massport does not have direct control over aircraft operations or fleet choices by the airlines, it continues to focus on areas that it controls in order to maximize the reduction of emissions from those sources it has an opportunity to influence.

1 Particulate matter (PM) less than or equal to 10 microns (PM_{10}) and PM less than or equal to 2.5 microns ($PM_{2.5}$) are subsets of PM.

Figure 7-1 Aircraft Engine Technology Has Evolved Over Time



In addition to those initiatives listed above, the following additional Massport initiatives benefit air quality:

- Provide pre-conditioned air (PCA) and 400-Hertz (Hz) power at all aircraft contact gates to reduce aircraft idling and auxiliary power unit (APU) use when not enough gates are available.
- Facilitate the replacement of gas- and diesel-powered GSE with electric equivalents by the end of 2027, where commercially available.
- Encourage single engine taxiing procedures by the airlines to reduce both noise and air emissions.
- Install 13 electric vehicle (EV)-charging stations to accommodate a total of 26 vehicles in the Central Garage and Terminal B parking areas. Massport commits to increasing the availability of EV charging stations so that 150 percent of this demand is available at all facilities at all times.
- Support the use of alternative fuel vehicles (AFV) by replacing older fleets with alternative fuel fleets.
- Operate one of the largest privately operated, publicly accessible, compressed natural gas (CNG) stations in New England.
- Use battery powered tugs and belt loaders for the Delta Air Lines ground service fleet at Terminal A.
- Continue operation of Massport's "Clean-Air-Cab" incentive program for AFVs.

One central element of Massport's emissions reduction initiative is a comprehensive strategy to diversify and enhance ground transportation options for passengers and employees. Massport is committed to reducing vehicle miles traveled (VMT) and associated emissions on Massport-controlled ground transport facilities (such as roadways and curbsides, parking facilities, and vehicle staging areas), as well as reducing VMT by Airport users traveling to and from the Airport. In addition to reducing VMT, on-Airport vehicle circulation improvements are underway. Massport's ground transportation strategy is designed to help reduce automobile-related air emissions and improve air quality by providing a broad range of HOV, public transit, and shared-ride options for travel to and from Logan Airport. The strategy also aims to reduce drop-off/pick-up modes by providing parking on-Airport for passengers choosing to drive or with limited HOV options. Continuing improvements to support HOV include: evaluating new Logan Express service offerings, investing in existing Logan Express sites (e.g., increasing parking capacity, increasing service frequency), implementing priority security lines for Logan Express riders, reducing urban Logan Express fares, and providing free Massachusetts Bay Transportation Authority (MBTA) Silver Line outbound boarding (from Logan Airport) and free Back Bay Logan Express outbound fares.

By enhancing the Airport roadway system, vehicles are able to circulate more efficiently, resulting in lower emissions. Within the parameters of the Logan Airport Parking Freeze, additional on-Airport parking is also being planned at the Terminal E surface lot and Economy Garage. This additional parking will reduce drop-off/pick-up activity to and from the Airport, reduce regional VMT and emissions, and aid in on-Airport circulation efficiency. Chapter 5, *Ground Access to and from Logan Airport,* provides detailed information on Massport's ground access and parking management strategy.

Massport also supports the use of alternative fuels by taxis; provides an on-Airport public-use, CNG station; provides electric plug-ins for electric GSE (eGSE); and installs and maintains 400-Hz power and pre-conditioned air at airplane gates to help reduce aircraft emissions. Currently, there are eight charging stations installed at

Logan Airport's TNC, black car limousine, and taxi sites, with eight additional stations planned to be installed by 2020. Further, Massport continues to invest in energy efficiency measures, such as the installation of solar panels and constructing facilities to meet the U.S. Green Building Council's (USGBC) LEED® standards. Together, these improvements help to reduce emissions associated with Logan Airport.

This chapter describes air quality conditions at Logan Airport in 2017, and compares them to those in 2016, previous years, and anticipated future conditions. Activity levels are expected to increase to approximately 50 million annual air passengers and 486,000 aircraft operations in the next 10 to 15 years (the Future Planning Horizon). In this *2017 ESPR,* the Future Planning Horizon serves as the basis for assessing future environmental effects of airport operations. This *2017 ESPR* provides an opportunity to revisit previous forecasts completed in 2011 and update them based on current and predicted conditions. The future emissions inventory is based on the Future Planning Horizon passenger activity levels, aircraft operations, and fleet mix. The most recent version of the FAA's AEDT was used to calculate the future emissions inventory. The model does not reflect the potential for significant design and operational improvements in aircraft engine technologies, alternative fuels, and aircraft operational measures in the future, which could lead to lower fuel use, improved combustion efficiencies, and lower emissions. Therefore, the predicted emissions in the Future Planning Horizon are likely to be conservatively high. There will be opportunities to revisit the future forecast based on the most current data available during the next ESPR cycle. For further information on the development of the future long-range forecast, refer to Chapter 2*, Activity Levels*.

Regulatory Framework

The federal Clean Air Act (CAA), National Ambient Air Quality Standards (NAAQS), and similar state laws govern air quality issues in Massachusetts. The NAAQS and the Massachusetts State Implementation Plan (SIP), which describes measures that the State will take to maintain and attain NAAQS compliance, regulate air quality issues in the Boston metropolitan area and the state. These regulations are discussed in the sections that follow.

National Ambient Air Quality Standards (NAAQS)

The EPA established NAAQS for a group of criteria air pollutants to protect public health, the environment, and quality of life from the detrimental effects of air pollution. These NAAQS are set for the following seven pollutants: carbon monoxide (CO), lead (Pb), nitrogen dioxide (NO_2), ozone (O_3), particulate matter (PM_{10}, $PM_{2.5}$), and sulfur dioxide (SO_2). The NAAQS primary standards (designed to protect human health) and secondary standards (designed to protect human welfare) are summarized in **Table 7-1**.

Based on air monitoring data, and in accordance with the CAA, all areas within Massachusetts are presently designated as either attainment and/or maintenance with respect to the NAAQS.[2,3] These regulatory designations for the Boston metropolitan area (including the area around Logan Airport) are listed in **Table 7-2**.

2 Environmental Protection Agency. *Nonattainment Areas for Criteria Pollutants (Green Book).* https://www.epa.gov/green-book.
3 An area with air quality better than the NAAQS is designated as attainment; an area with air quality worse than the NAAQS is designated as nonattainment; and an area that is in transition from nonattainment to attainment is designated as

The Boston area is currently designated as "Attainment/Maintenance" for CO, indicating that it is in transition back to "Attainment" for this pollutant. Historically, the entire Boston area was designated as "Attainment" for all other criteria pollutants except O_3, for which it was designated as "Moderate/Nonattainment" based on the former 1997 8-hour O_3 NAAQS (see **Table 7-2**). This previous O_3 Nonattainment area encompassed 10 counties in Massachusetts: Barnstable, Bristol, Dukes, Essex, Middlesex, Nantucket, Norfolk, Plymouth, Suffolk, and Worcester.[4]

In May 2012, EPA issued a "Clean Data Finding" for the Boston metropolitan area signifying that the area had attained the 1997 NAAQS for O_3. This re-designated the area as "Attainment/Maintenance," as long as the area continued to demonstrate attainment based on ongoing monitoring data. In addition, the "Anti-Backsliding" requirements of CAA (a rule established to ensure that air quality is not deteriorated due to changes in the NAAQS) still obligates the Massachusetts Department of Environmental Protection (MassDEP) to enforce certain elements of the SIP that were established to attain the 1997 NAAQS.

In April 2012, EPA also implemented the newer, stricter, 2008 8-hour O_3 NAAQS. Since that time, there have been no violations of this standard and this trend has continued through 2017. Based on these recent findings, MassDEP submitted the SIP for O_3 to EPA in 2014 for "Adequacy Review" and in February 2018 received certification that its existing emission statement program satisfies the CAA requirements for the 2008 O_3 NAAQS. Therefore, the Boston metropolitan area is presently designated as "Attainment/Unclassifiable" with respect to the 2008 O_3 standard.

Finally, EPA has again revised and made stricter the O_3 standard that became effective in 2015. The Attainment/Nonattainment designations for this standard were made in 2018 based upon the previous three years of statewide monitoring data. EPA has designated all of Massachusetts, including the Boston metropolitan area, as Attainment/Unclassifiable for the 2015 8-hour O_3 standard. Currently, there are no state or federal air quality standards for outdoor levels of ultrafine particles (UFPs). Massport is actively tracking the research and regulatory status of this pollutant and will comply with future UFP standards if promulgated by EPA.

attainment/maintenance. An area may also be designated as unclassifiable when there is a temporary lack of data to form a basis for determining attainment status. Nonattainment areas can be further classified as extreme, severe, serious, moderate, and marginal by the degree of non-compliance with the NAAQS.

4 Logan Airport is located in Suffolk County.

Table 7-1 National Ambient Air Quality Standards

Pollutant	Primary/ Secondary	Averaging Time	Standard ppm	Standard μg/m³	Notes
Carbon Monoxide (CO)	Primary	1 hour	35	40,000	Not to be exceeded more than once a year.
		8 hour	9	10,000	Not to be exceeded more than once a year.
Lead (Pb)	Primary and Secondary	Rolling 3-Month Average	—	0.15	Not to exceed this level. Final rule October 2008.
Nitrogen Dioxide (NO_2)	Primary	1 hour	0.100	188	The 3-year average of the 98th percentile of the daily maximum 1-hour average at each monitor within an area must not exceed 0.100 ppm.
	Primary and Secondary	Annual	0.053	100	Not to exceed this level.
Ozone (O_3)	Primary and Secondary	8 hour[1]	0.070	—	Annual fourth-highest daily maximum 8-hour concentration, average over 3 years.
Particulate Matter with a diameter ≤10μm (PM_{10})	Primary and Secondary	24 hour	—	150	Not to be exceeded more than once a year on average over 3 years.
Particulate Matter with a diameter ≤2.5μm ($PM_{2.5}$)	Primary and Secondary	24 hour	—	35	The 3-year average of the 98th percentile for each population-oriented monitor within an area is not to exceed this level.
	Primary	Annual	—	12	The 3-year average of the weighted annual mean from single or multiple monitors within an area is not to exceed this level.
	Secondary	Annual	—	15	The 3-year average of the weighted annual mean from single or multiple monitors within an area is not to exceed this level.
Sulfur Dioxide (SO_2)	Primary	1 hour	0.075	196	Final rule signed June 2, 2010. The 3-year average of the 99th percentile of the daily maximum 1-hour average at each monitor within an area must not exceed this level.
	Secondary	3 hour	0.5	1,300	Not to be exceeded more than once a year.

Source: EPA, 2019 (https://www.epa.gov/criteria-air-pollutants).

Notes: There is no NAAQS standard for NO_x.

μm – micrometers; μg/m³ – micrograms per cubic meter; ppm – parts per million.

1 Final rule signed October 1, 2015, and effective December 28, 2015. The previous (2008) O_3 standard additionally remains in effect in some areas. Revocation of the 2008 standard and transition to the new standard will be achieved over the next three years.

Table 7-2 Attainment/Nonattainment Designations for the Boston Metropolitan Area

Pollutant	Designation
Carbon monoxide (CO)	Attainment/Maintenance[1]
Nitrogen Dioxides (NO_2)	Attainment
Ozone (8-hour, 1997 Standard)	Attainment/Maintenance[1]
Ozone (8-hour, 2008 Standard)	Attainment/Unclassifiable[2]
Ozone (8-hour, 2015 Standard)	Attainment/Unclassifiable
Particulate matter (PM_{10})	Attainment
Particulate matter ($PM_{2.5}$)	Attainment
Sulfur Dioxide (SO_2)	Attainment
Lead (Pb)	Attainment

Source: EPA, 2019 (https://www.epa.gov/green-book).
1 The Boston area was previously designated nonattainment for this pollutant but has since attained compliance with the National Ambient Air Quality Standards (NAAQS). Notably, the 8-hour Ozone (1997) NAAQS was revoked on April 6, 2015.
2 Attainment/Unclassifiable means that the initial data shows attainment, but additional data is needed to verify longer-term conditions.

Massachusetts State Implementation Plan (SIP)

The Massachusetts SIP is the State's regulatory plan for bringing nonattainment areas into compliance with the NAAQS. As discussed previously, the entire Boston metropolitan area was formerly designated as "Moderate" Nonattainment for the 1997 8-hour O_3 standard but has since received a "Clean Data Finding" from EPA classifying the area as "Attainment/Maintenance." Additionally, and as stated above, the area has recently been designated Attainment/Unclassifiable for both the 2008 and 2015 8-hour O_3 standards and, accordingly, the SIP should reflect these current designations. For the former CO Attainment/Maintenance designation, MassDEP has also developed another 10-year Maintenance Plan, which is presently in place. The most current SIPs applicable to the Boston area are summarized in **Table 7-3**.

The number of commercial and employee parking spaces allowed at Logan Airport is regulated by the Logan Airport Parking Freeze (310 Code of Massachusetts Regulations 7.30), which is an element of the Massachusetts SIP under the federal CAA (42 U.S.C. §7401 et seq. [1970]). The intent of the Logan Airport Parking Freeze is to reduce air emissions by shifting air passengers to travel modes that require fewer vehicle trips. However, survey data since the 1970s has consistently shown that constrained parking has the unintended consequence of shifting air passengers to travel modes with higher numbers of vehicle trips, despite Massport's extensive efforts to provide and encourage the use of HOV travel modes. As one element of its comprehensive transportation strategy, Massport proposed to increase the Logan Airport Parking Freeze by 5,000 on-Airport commercial parking spaces at Logan Airport. The goal of the Logan Airport Parking Project is to reduce the number of air passengers choosing more environmentally harmful drop-off/pick-up modes, which generate up to four vehicle trips instead of two. As part of the process to amend the Logan Airport Parking Freeze, MassDEP conducted a stakeholder process, which was followed by a public process to amend the Parking Freeze regulation. MassDEP issued the amended regulation on June 30, 2017, approving the

requested parking increase. On December 5, 2017, EPA proposed a rule approving the revision of the Massachusetts SIP incorporating the amended Logan Airport Parking Freeze. This amendment was finalized on March 6, 2018 and went into effect on April 5, 2018. For additional information, see Chapter 5, *Ground Access to and from Logan Airport*.

Logan Airport Air Quality Permits for Stationary Sources of Emissions

Massport was originally granted a Title V Air Quality Operating Permit for Logan Airport in September 2004, and the most recent renewal was granted in January 2013, which still applied in 2017. This permit covers all of the Massport-operated stationary sources including the Central Heating and Cooling Plant, snow melters, fuel dispensers, boilers, emergency electrical generators, and fuel storage tanks.

Table 7-3 State Implementation Plan (SIP) for Boston Area

Standard	Title	Status	Comments
Carbon Monoxide (CO)	Maintenance Plan	Published in 2018	This second 10-year Maintenance Plan is required for any area that was formerly designated as non-attainment to show that it will not regress to this status. This maintenance plan meets the requirements of Section 175A of the Clean Air Act (CAA) and conforms to U.S. Environmental Protection Agency (EPA) guidance for CO maintenance plans.[1]
Ozone (O_3)	2008 SIP	Submitted to EPA in 2014 – Certified February 2018	In January 2017, EPA conditionally approved the Massachusetts Department of Environmental Protection's (MassDEP's) infrastructure SIP Certification, noting that the transport components still needed to be submitted. In February 2018, EPA certified the interstate air pollution transport requirements, completing MassDEP's SIP Certification.[2]
Ozone (O_3)	2015 SIP	Certified September 2018	In October 2015, EPA lowered (i.e., made stricter) the National Ambient Air Quality Standards (NAAQS) for O_3. In September 2018, MassDEP's infrastructure SIP was certified. This certification fulfilled the infrastructure requirements of CAA Sections 110(a)(1) and (2), as well as interstate transport requirements in Section 110(a)(2)(D)(i)[3].

Source: MassDEP (https://www.mass.gov/lists/massachusetts-state-implementation-plans-sips#ozone-sip-).

Notes: The number of commercial and employee parking spaces allowed at Logan Airport is regulated by the Logan Airport Parking Freeze (310 Code of Massachusetts Regulations 7.30 and 40 Code of Federal Regulations 52.1120), which is an element of the State Implementation Plan (SIP) under the federal Clean Air Act (CAA).

1 MassDEP, *Second 10-Year Limited Maintenance Plan for the Boston Metropolitan Area, Lowell, Springfield, Waltham, and Worcester*, February 9, 2018.

2 MassDEP, *Certification of Adequacy of Massachusetts State Implementation Plan with Clean Air Act Section 110(a)(2)(D)(i) Interstate Air Pollution Transport Requirements for the 2008 Ozone National Ambient Air Quality Standards*, February 9, 2018.

3 MassDEP, *Certification of Adequacy of the Massachusetts State Implementation Plan Regarding Clean Air Act Section 110(a)(1) and (2) for the 2015 Ozone National Ambient Air Quality Standards*, September 27, 2018.

Assessment Methodology

For the purposes of the *2017 ESPR*, the analysis of air emissions associated with Logan Airport operations includes the source categories described below, each of which has its own assessment methodology, database, and assumptions. For this *2017 ESPR*, Massport has used the FAA's AEDT[5] for air quality modeling of aircraft-related emissions, which has replaced the legacy EDMS. The AEDT model was used for the first time in the *2016 EDR*.

FAA Aviation Environmental Design Tool (AEDT)

The AEDT model was released in 2015 and is FAA's approved computer model for calculating emissions from aircraft-related sources (e.g., aircraft engines, APUs, GSE, etc.). As discussed in Chapter 6, *Noise Abatement*, AEDT is also designed to assess airport noise and replaces the legacy Integrated Noise Model (INM). The AEDT model was developed to incorporate the most updated and best-available science. The latest version of AEDT is 2d (AEDT 2d), which was released in February 2018. AEDT 2d supersedes the previous model version AEDT 2c Service Pack 2 (AEDT 2c SP2) used in the 2016 air quality analysis. From an air quality perspective, the primary differences between the two model versions are the databases associated with emission factors and aircraft/engine combinations, briefly described below:

- **Emission Factors** – Per FAA's *AEDT 2d Release Notes*, engine databases in AEDT 2d have been updated with aircraft engine emission factor data from the International Civil Aviation Organization's (ICAO's) Emissions Databank v.23.c.[6] These updated emission factors result in aircraft emissions that vary between the two model versions.
- **Aircraft/Engine Combinations** – Mostly pertaining to newer aircraft, there are some aircraft/engine combinations that exist in AEDT 2d but did not exist in the AEDT 2c SP2 version. The AEDT 2d aircraft/engine combinations database was recently updated to include 482 new combinations. For example, the B787-900/Trent 1000-A combination exists in AEDT 2d but did not exist in the AEDT 2c SP2 version.

As a result of the variances in engine emission factors and available aircraft/engine combinations, AEDT 2d computes lower aircraft emissions of VOC and CO in comparison to the AEDT 2c SP2 model version. However, NO_x and PM_{10}/$PM_{2.5}$ emissions are slightly higher (less than 1 percent). For comparison purposes, the differences between the AEDT 2d and AEDT 2c SP2 aircraft emissions are shown in **Table 7-4** for 2017.

Since its release, FAA continues to enhance the AEDT model by expanding its capabilities, correcting computational errors, and making it more user-friendly. These improvements are reflected in periodic version releases of the model, which are expected to continue for the foreseeable future.

5 The Aviation Environmental Design Tool (AEDT) is a software system that models aircraft performance in space and time to estimate fuel consumption, emissions, noise, and air quality consequences. AEDT is a comprehensive tool that provides information to Federal Aviation Administration stakeholders on each of these specific environmental impacts. AEDT facilitates environmental review activities by consolidating the modeling of these environmental impacts in a single tool. AEDT is designed to model individual studies ranging in scope from a single flight at an airport to scenarios at the regional, national, and global levels (https://aedt.faa.gov/).

6 Federal Aviation Administration. February 12, 2018. AEDT 2d Release Notes (revision 93.1.7128.1).

Table 7-4 AEDT 2d and AEDT 2c SP2 Aircraft Emissions Inventory Comparison

	Pollutant (kg/day)			
Model	**VOC**	**NO_x**	**CO**	**$PM_{10}/PM_{2.5}$**
2016 AEDT 2c SP2	798	4,897	6,166	60
2017 AEDT 2c SP2	814	5,548	6,359	42
2017 AEDT 2d	778	5,577	5,926	43
% Difference between 2017 AEDT 2d versus 2017 AEDT 2c SP2	**(4.4%)**	**0.5%**	**(6.8%)**	**0.6%**
% Difference between 2017 AEDT 2c SP2 versus 2016 AEDT 2c SP2	**1.9%**	**13.3%**	**3.1%**	**(29.3%)**
% Difference between 2017 AEDT 2d versus 2016 AEDT 2c SP2	**(2.5%)**	**13.9%**	**(3.9%)**	**(28.8%)**

Source: Massport and KBE, 2019.
Notes: Negative numbers are shown in ( ).
Modeled emissions totals are rounded numbers. Percent calculations based on exact numbers.
CO – carbon monoxide; NO_X – oxides of nitrogen; PM – particulate matter; VOC – volatile organic compound.

2017 Air Quality Assessment Methodology

- **Aircraft Emissions** – FAA's AEDT is now the EPA-preferred and the FAA-required model for calculating aircraft-related emissions. As previously stated, the most recent version of AEDT is AEDT 2d, which was used in support of the 2017 air quality analysis. For consistency with prior EDRs and ESPRs, the findings from the previous model, AEDT 2c SP2, were also used for comparison purposes to discern which changes are attributable to the model version differences and which changes are attributable to changes in operations and other factors.

  As for past years, the actual 2017 aircraft fleet mix at Logan Airport was used as input to AEDT. In a few instances where the aircraft/engine type combinations operating at Logan Airport were not available in the AEDT database, substitutions were made based on the closest match of aircraft and engine types using professional judgement. **Table I-4** in Appendix I, *Air Quality/Emissions Reduction,* contains the data that were used to program the different model versions, including the aircraft and engine types, numbers of landings and takeoffs (LTOs), and aircraft taxi/delay times for 2017. Following previous methodology, the Logan Airport aircraft fleet was grouped into four categories: commercial air carriers, commuter aircraft, general aviation (GA), and cargo aircraft.

  According to these data, from 2016 to 2017, total LTOs increased by 2.6 percent with air carrier LTOs decreasing by 0.1 percent, commuter LTOs increasing by 13.4 percent, air cargo LTOs increasing by about 1.1 percent, and GA increasing by 1.2 percent.

  Updated aircraft taxi/delay times are based on data obtained from the FAA Aviation System Performance Metrics (ASPM) database for 2017.[7] According to this database, the average aircraft taxi/delay times at Logan Airport increased from 25.3 to 26.6 minutes from 2016 to 2017 or 4.9 percent.

7 Federal Aviation Administration (FAA). 2017. FAA Aviation System Performance Metrics (ASPM) Database. https://aspm.faa.gov/.

- **Ground Service Equipment** – Estimates of GSE emissions were based on AEDT emission factors and continue to reflect emission reductions attributable to Massport's AFV Program and the conversion of Massport and/or tenant GSE and fleet vehicles to CNG or electric. GSE emission factors decreased measurably for most equipment in 2017 when compared to 2016. Other AEDT input data are based on the updated Logan Airport-specific GSE time-in-mode (TIM) survey conducted in 2017, combined with the most recent GSE fuel use (i.e., gasoline, diesel, liquid petroleum gas, and electric) data from Massport's Vehicle Aerodrome Permit Application Program for Logan Airport.

- **Motor Vehicles** – Motor vehicle emission factors were obtained from the new, and most recent, version of EPA's Motor Vehicle Emission Simulator (MOVES) model (MOVES2014b) combined with MassDEP-recommended motor vehicle fleet mix data, operating conditions, and other Massachusetts-specific input parameters. In general, the emission factors obtained from MOVES2014b for 2017 were lower for VOCs, NO_x, CO, and PM when compared to 2016. The MOVES input/output files are included in Appendix I, *Air Quality/Emissions Reduction*. In addition, Chapter 5, *Ground Access to and from Logan Airport,* of this *2017 ESPR* provides a discussion of the on-Airport VMT data used for this analysis. On-Airport VMT and vehicle speed data were predicted by the traffic simulation model, VISSIM.[8] (Refer to Chapter 5, *Ground Access to and from Logan Airport,* for more information.)

- **Other Sources** – Emissions associated with fuel storage and handling, the Central Heating and Cooling Plant, snow melters, emergency generators, space heaters, and fire training at Logan Airport were based on annual fuel throughput records for 2017, combined with appropriate EPA emission factors (for example, compilation of Air Pollution Emission Factors [AP-42], manufacturer provided emission factors, or emission factors obtained from NO_x Reasonably Available Control Technology compliance testing). When comparing actual fuel burned in 2017 to 2016, No. 2 fuel oil usage from stationary sources decreased by about 78 percent and natural gas usage increased by about 14 percent. The large decrease in No. 2 fuel oil usage is primarily due to the shift to natural gas usage. Between 2015 and 2018, all No. 2 fuel oil fired boilers were removed from the South Cargo Area and replaced with high efficiency gas boilers. Emissions from other sources[9] represent 35 percent of the overall total VOC emissions and 3 percent, or less, of total NO_x, CO, and PM_{10}/$PM_{2.5}$ emissions.

  In November 2014, Massport converted the Central Heating and Cooling Plant fuel oil system from No. 6 to No. 2 fuel oil. During the conversion, the plant retained the ability to burn natural gas, which it burns approximately 97 percent of the time. Converting the Central Heating and Cooling Plant fuel oil system allows Massport to reduce energy use and air emissions while maintaining the ability to use backup fuel oil in the event of a disruption of natural gas service. Massport is planning to upgrade the Central Heating and Cooling Plant at Logan Airport to accommodate the anticipated increase in heating load for the Terminal E expansion. The project will include replacing the existing dual fuel Boiler 3 with a new natural gas fired boiler of approximately the same capacity

- **Particulate Matter** – Estimates of PM emissions associated with Logan Airport activities were first reported in the *2005 EDR* in response to the then recent availability of an FAA-updated method (First Order Approximation) for computing aircraft PM_{10}/$PM_{2.5}$ emission factors. PM_{10}/$PM_{2.5}$ emissions are now routinely reported in the EDRs, including this *2017 ESPR*.

8 PTV America. (2011). Verkehr In Städen Simulationsmodell- VISSIM version 5.40 [computer software]. Portland, OR.

9 Other sources include Central Heating and Cooling Plant, emergency generators, snow melters, fuel storage/handling and live fire training facility activities.

- **Greenhouse Gases** - GHG emissions are calculated in much the same way as criteria pollutants (and their precursors). This includes the use of input data such as activity levels or material throughput rates (such as, fuel usage, VMT, electrical consumption, etc.) that are applied to appropriate emission factors (for example, in units of GHG emissions per gallon of fuel). Again, these input data were either based on Massport records or data derived from the models. Global Warming Potentials (GWPs) and emission factors were obtained from the Intergovernmental Panel on Climate Change (IPCC) and EPA, respectively.

  Consistent with prior EDR and ESPR years, the 2017 GHG emissions inventory includes aircraft operations within the taxi-idle/delay mode and up to the top of the 3,000–foot LTO cycle. GHG emissions associated with GSE, APUs, motor vehicles, a variety of stationary sources, and electricity usage were also included following the guidance issued by the Airport Cooperative Research Program Report 11, *Guidebook on Preparing Airport Greenhouse Gas Emissions Inventories*.

  Massport has direct ownership or control over a small percentage (12.7 percent in 2017) of Logan Airport-related GHG emissions and their sources (mostly limited to Massport fleet vehicles, stationary sources, and electrical consumption within Massport buildings). As with most commercial service airports, the vast majority of the GHG emission sources are owned, controlled, or generated by the airlines, other airport tenants, and the general public (motor vehicles).

In all cases, Massport undertakes a variety of programs to reduce non-Massport Airport-related emissions through its support of HOV initiatives, including: subsidizing free outbound Silver Line Service from Logan Airport; supporting use of alternative fuels by airport taxis; providing an on-Airport CNG station; and providing electric plug-ins for GSE, facilitating the replacement of gas- and diesel-powered GSE with electric GSE (eGSE), 400-Hz power, and pre-conditioned air at airplane gates.

Emissions Inventory in 2017

This section provides the results of the 2017 Logan Airport emissions inventory for the pollutants CO, NO_x, PM_{10}/$PM_{2.5}$, and VOCs using the AEDT 2d and MOVES2014b models, and standard emission factors for stationary sources. The following section reports on aircraft-related emissions using the AEDT 2d model and compares it to the AEDT 2c SP2 model version for aircraft-related emissions. Emissions of O_3 are not directly computed as it is a secondary pollutant formed by the interactions of NO_x and VOCs throughout the region. Emissions of SO_2 and Pb are also not computed, as Logan Airport emission sources are very small generators of these two EPA criteria pollutants.

As stated above, the aircraft emissions inventory was computed based on the actual number of aircraft operations, fleet mix, and operational times-in-mode at the Airport in 2017. Similarly, emissions associated with GSE, APUs, motor vehicles, fuel storage and transfer facilities, and a variety of stationary sources (such as steam boilers, snow melters, live-fire training, space heaters, and emergency generators) associated with Logan Airport were also computed based on actual conditions.

As in previous EDRs and ESPRs, the 2017 emissions inventory for Logan Airport is used for short-term comparisons to the *2016 EDR* results, as well as for long-term comparisons to previous EDRs and ESPRs extending back to 1990. For ease of review, the tables and figures containing the 2017 results also show the results for 1990 and 2000 and then annually for 2010 to 2016. In this way, the changes in Logan Airport air quality conditions can be evaluated in both the short- and long-term timeframes and on a common basis.

The changes in emissions year-to-year is a function of several variables. These include growth in operations and changes in the aircraft fleet, advancements in aircraft engine technologies, improved airfield efficiencies, and Massport's emission reduction measures such as the GSE replacement initiative. Another important factor involves the continuous evolution of air quality models. An example of the effects of model versions on analysis results is discussed below.

As shown in **Table 7-5**, the 2017 AEDT 2d estimates lower amounts of emissions of VOCs, CO, and $PM_{10}/PM_{2.5}$ and higher NO_x emissions in comparison to 2016 AEDT 2c SP2. The differences in results between the 2017 AEDT 2d and 2016 AEDT 2c SP2 are due, in part, to the difference in operations, taxi times, and fleet mix between the two analysis years. For example, 2017 operations are up when compared to 2016. However, the taxi times and fleet mix differ only slightly. The following sections compare in detail the air emission results (by pollutant and source) between 2017 and 2016.

Table 7-5 Total Emissions Inventory Comparison, 2016 to 2017

	Pollutant (kg/day)			
Model	**VOC**	**NO_x**	**CO**	**$PM_{10}/PM_{2.5}$**
2016 AEDT 2c SP2/MOVES2014a	1,280	5,300	7,350	96
2017 AEDT 2d/MOVES2014b	1,273	5,935	7,092	77
% Difference 2016 to 2017	**(0.6%)**	**12.0%**	**(3.5%)**	**(20.1%)**

Source: Massport and KBE, 2019.
Notes: Negative numbers are shown in ( ).
Modeled emissions totals are rounded numbers. Percent calculations based on exact numbers.
CO – carbon monoxide; NO_X – oxides of nitrogen; PM – particulate matter; VOC – volatile organic compound.

Volatile Organic Compounds (VOCs)

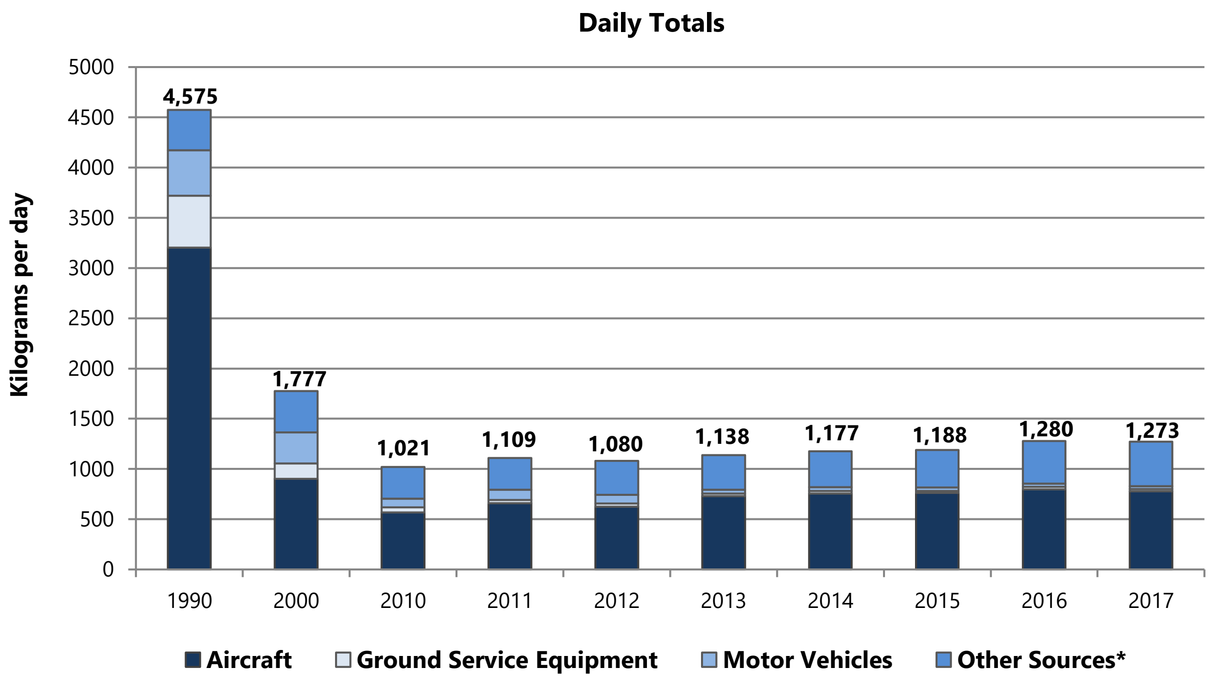
In 2017, total VOC emissions at Logan Airport were 512 tons per year (tpy) (or 1,273 kilograms per day [kg/day]) – a decrease of less than 1 percent from 2016 levels. The long-term trend for VOC emissions reveals a substantial decrease in these emissions associated with Airport activities. **Figure 7-2** depicts the overall, long-term downward trend in VOC emissions at Logan Airport and **Figure 7-3** shows the percent breakdown of these emissions by source category in 2017. Similarly, **Table 7-6** shows the computed VOC emissions in kg/day for each emission source from 1990, 2000, and 2010 to 2017. Other key findings from this analysis include the following:

- Total aircraft-related VOC emissions decreased by 2.5 percent in 2017 (AEDT 2d) compared with 2016 (AEDT 2c SP2). The decrease in 2017 compared to 2016 was largely due to differences in fleet mix between 2016 and 2017 as well as model version differences between AEDT 2d and 2c SP2, as previously discussed.
- GSE-related VOC emissions were approximately 10 percent lower in 2017 than in 2016. This was largely due to the change in fleet mix between the two analysis years, which subsequently affects the GSE assignment to an aircraft. The differences in fleet mix also lowered run times, reducing overall GSE-related emissions.
- VOC emissions from motor vehicles in 2017 decreased by about 6.4 percent from 2016 levels. This decrease was mostly attributable to lower motor vehicle emission factors.
- VOC emissions from stationary and other non-mobile sources (fuel storage/handling, Central Heating and Cooling Plant, snow melter usage, firefighter training, etc.) increased by approximately 4 percent from 2016 to 2017. This change was mostly due to the increase in evaporative emissions from refueling activities.

As shown in **Figure 7-3**, in 2017, aircraft continued to represent the largest source (61 percent) of VOC emissions associated with Logan Airport, followed by other sources (35 percent), motor vehicles (2 percent), and GSE (2 percent).

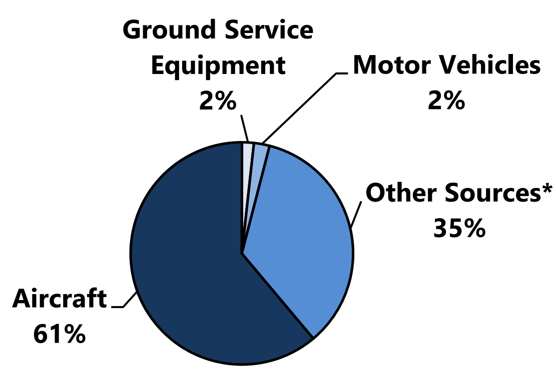
The long-term decline and leveling-off of VOC emissions associated with Logan Airport is especially significant to ozone in the Boston area. VOCs and NO_x are the two main pollutants involved in ozone formation. However, like most urban environments, Boston is characterized as "VOC-Limited" for ozone. This means that reductions in VOCs are more beneficial (i.e., ozone-level lowering) than increases in NO_x are undesirable (i.e., ozone-level increasing). In other words, ozone formation is impacted more by VOCs than by NO_x. Therefore, the approximate 25-year trend in VOC emissions illustrated in **Figure 7-2** and summarized in **Table 7-6** represents a potential counterbalance to the increase in NO_x emissions shown below.

Figure 7-2 Modeled Emissions of VOCs at Logan Airport, 1990, 2000, and 2010-2017



Source: Massport and KBE, 2019.
Notes: Other sources include miscellaneous sources (i.e., Central Heating and Cooling Plant, snow melter usage, fire training, etc.) and fueling sources.
In 2017, aircraft-related emissions were calculated using AEDT 2d and motor vehicles were calculated using MOVES2014b.

Figure 7-3 Sources of VOC Emissions, 2017



Source: Massport and KBE, 2019.
Notes: Other sources include stationary sources (e.g., Central Heating and Cooling Plant, snow melter usage, fire training, etc.) and fueling sources.
In 2017, aircraft-related emissions were calculated using AEDT 2d and motor vehicles were calculated using MOVES2014b.

Table 7-6 Estimated VOC Emissions (in kg/day) at Logan Airport, 1990, 2000, and 2010-2017[1]

Aircraft/GSE Model:	**Logan Dispersion Modeling System (LDMS)**	**EDMS v4.03**	**EDMS v5.1.2**	**EDMS v5.1.3**					**EDMS v5.1.4.1**					**AEDT Version 2c SP2**		**AEDT Version 2d**
Motor Vehicle Model:	**MOBILE 5a**	**MOBILE 6.0**	**MOBILE 6.2.03**					**MOVES 2010b**	**MOVES 2014**		**MOVES 2014a**				**MOVES 2014b**
Year:	**1990**	**2000**	**2010**		**2011**	**2012**	**2013**		**2014**		**2015**	**2016**		**2017**	
Aircraft Sources															
Air carriers	2,175	514	292	292	305	378	448	447	480	480	491	504	553	516	517
Commuter aircraft	681	140	129	125	110	91	91	91	85	85	87	79	74	65	77
Cargo aircraft	303	207	70	70	69	63	44	44	48	48	47	56	61	50	50
General aviation	44	42	81	81	176	93	149	149	144	144	135	121	110	183	134
Total aircraft sources	3,203	903	572	568	660	626	732	731	757	757	761	760	798	814	778
Ground service equipment[2]	518	153	49	49	33	30	26	26	23	23	21	24	24	22	22
Motor Vehicles															
Ted Williams Tunnel through-traffic	N/A	12	–[3]	–[3]	–[3]	–[3]	–[3]	–[3]	–[3]	–[3]	–[3]	–[3]	–[3]	–[3]	–[3]
Parking/curbside[4]	192	89	20	20	20	18	17	5	3	4	4	3	3	3	3
On-airport vehicles	258	206	68	68	81	70	67	31	16	34	30	28	28	26	26
Total motor vehicle sources	450	307	86	86	101	88	84	36	19	38	34	31	31	29	29

Table 7-6 Estimated VOC Emissions (in kg/day) at Logan Airport, 1990, 2000, and 2010-2017[1] (Continued)

Aircraft/GSE Model:	Logan Dispersion Modeling System (LDMS)	EDMS v4.03	EDMS v5.1.2	EDMS v5.1.3				EDMS v5.1.4.1					AEDT Version 2c SP2		AEDT Version 2d
Motor Vehicle Model:	**MOBILE 5a**	**MOBILE 6.0**	**MOBILE 6.2.03**					**MOVES 2010b**	**MOVES 2014**		**MOVES 2014a**				**MOVES 2014b**
Year:	**1990**	**2000**	**2010**		**2011**	**2012**	**2013**		**2014**		**2015**	**2016**		**2017**	
Other Sources															
Fuel storage/handling	400	412	311	311	311	332	340	340	354	354	366	422	422	439	439
Miscellaneous sources[5]	4	2	5	5	4	4	5	5	5	5	6	5	5	5	5
Total other sources	404	414	316	316	315	336	345	345	359	359	372	427	427	444	444
Total Airport Sources	4,575	1,777	1,025	1,021	1,109	1,080	1,187	1,138	1,158	1,177	1,188	1,242	1,280	1,308	1,273

Source: Massport and KBE, 2019.

Notes: N/A – not available.

kg/day - kilograms per day. 1 kg/day is equivalent to approximately 0.40234 tons per year (tpy).

Years 2010, 2013 and 2016 were computed with previous years' EDMS versions to provide for a common basis of comparison. Years 2013 and 2014 were also computed with the previous years' motor vehicle emission factors models. Year 2017 was computed with current and previous versions of AEDT and MOVES.

1 See Appendix I, *Air Quality/Emissions Reduction,* for 1993 to 2009 emission inventory results.

2 Ground service equipment (GSE) emissions include aircraft auxiliary power units (APUs) as well as vehicles and equipment converted to alternative fuels.

3 Due to the new roadway configuration and opening of the Ted Williams Tunnel there was no Ted Williams Tunnel through-traffic (which is defined as traffic passing through but not destined for the Airport) at Logan Airport beginning in 2003.

4 Parking/curbside is based on vehicle miles traveled (VMT) analysis.

5 Includes the Central Heating and Cooling Plant, emergency electricity generation, snow melter usage, and other stationary sources.

Oxides of Nitrogen (NO_x)

In 2017, total NO_x emissions from all Airport-related sources were estimated to be 2,388 tpy (5,935 kg/day), which represents an increase of about 12 percent from 2016 levels. This change is largely due to differences in aircraft fleet mix and increases in the number of LTOs and taxi times. In 2017, aircraft taxi times increased by 4.9 percent. **Figure 7-4** illustrates short- and long-term trends in NO_x emissions and **Table 7-8** shows the NO_x contribution for each emission source in 1990, 2000, and 2010 through 2017.

As discussed above, NO_x is one of the two principal precursors to ozone formation (the other being VOCs); however, there are no NAAQS standards for NO_x or VOCs individually. However, the Boston Metropolitan Area is presently designated as Attainment/Unclassifiable for ozone, meaning that the area complies with the NAAQS for this pollutant. Together with VOCs, emissions of NO_x associated with industry, transportation, agriculture and other land uses contribute to ozone levels throughout the Northeast. As regional pollutants, the interrelationship between NO_x and VOC emissions are important, as described in the bullets that follow.

- The movement of emissions in the atmosphere regionally (i.e., transport of NO_x and VOCs from outside the region) is significant and contributes substantially to ozone levels in the Boston area.
- Boston is generally characterized as "VOC-Limited" for ozone. This means that reductions in VOCs are more beneficial than increases in NO_x are detrimental.
- As reported, Logan Airport-related emission estimates of VOCs are decreasing while NO_x emissions are increasing. When it comes to ozone-formation, the relationship between NO_x and VOCs is not always one-to-one. In the Boston area specifically, where VOCs are the most important in ozone formation, the reductions in VOCs at Logan Airport help to moderate the effects of NO_x.

Total Logan Airport NO_x emissions are approximately 2 percent of statewide emissions as shown in **Figure 7-6**. MassDEP currently monitors NO_x in the Boston Metropolitan Area.

AMONG MASSPORT'S STRATEGIC INITIATIVES TO MINIMIZE NO_x EMISSIONS AIRPORT-WIDE, ONGOING INVESTMENTS IN CLEANER AND MORE EFFICIENT FUEL COMBUSTION TECHNOLOGIES ARE DELIVERING IMMEDIATE AND MEASURABLE AIR QUALITY BENEFITS. FOR STATIONARY SOURCES, MASSPORT HAS CONTINUED TO MODERNIZE AIRPORT BOILERS, EMERGENCY GENERATORS, AND SNOWMELTERS. OVER THE NEXT TWO YEARS, THIS ACTION WILL RESULT IN EMISSIONS REDUCTIONS OF APPROXIMATELY 7 TONS PER YEAR OR ABOUT 28 PERCENT LESS THAN IS ALLOWABLE UNDER FEDERAL AND STATE REGULATIONS FOR STATIONARY SOURCE EMISSIONS.

Effect of Aircraft Engine Technology on NO_x

As shown in **Figure 7-5**, aircraft emissions continue to represent the largest source (94 percent) of NO_X at Logan Airport, followed by other sources (3 percent), GSE (2 percent), and motor vehicles (1 percent). This is an important distinction as Massport does not have any control over aircraft emissions, which is the vast majority of the total.

As can be seen from **Table 7-7** where representative aircraft are compared, as aircraft engines become quieter (improving from Stage 3 to Stage 5), the criteria pollutants levels of VOCs and CO decrease, while NO_x increases, and PM stays roughly the same. This is a function of aircraft engines becoming quieter and more efficient, but with an increase in NO_x emissions.

As a means of reducing amounts and costs of fuel use, aircraft engine designers and manufacturers are producing more “fuel-efficient” (i.e., less fuel-burning) engines. This is achieved by enhancing engine performance with improved fuel combustion technologies, greater thrust-generating power, and less engine wear. Aircraft are also being designed to decrease fuel-burn with advancements in aircraft wing and body aerodynamics, light-weight alloy materials and improved means of navigation. These emerging technologies and reduced fuel burn are expected to reduce emissions, reduce noise, and moderate the growth in NO_x emissions into the future.

Table 7-7 Example Stage 3, Stage 4, and Stage 5 Aircraft Types Operating at Logan Airport

			Air Quality (kg/LTO)			
Name	**Model**	**Noise Stage Equivalent**	**VOC**	**NO_x**	**CO**	**PM**
737-300	CFM56-3-B1	3	1.4	5.5	13.5	0.05
737-700	CFM56-7B22	4	1.3	7.2	7.8	0.05
787-8R	Trent 1000-A2	5	0.5	25.3	7.0	0.07

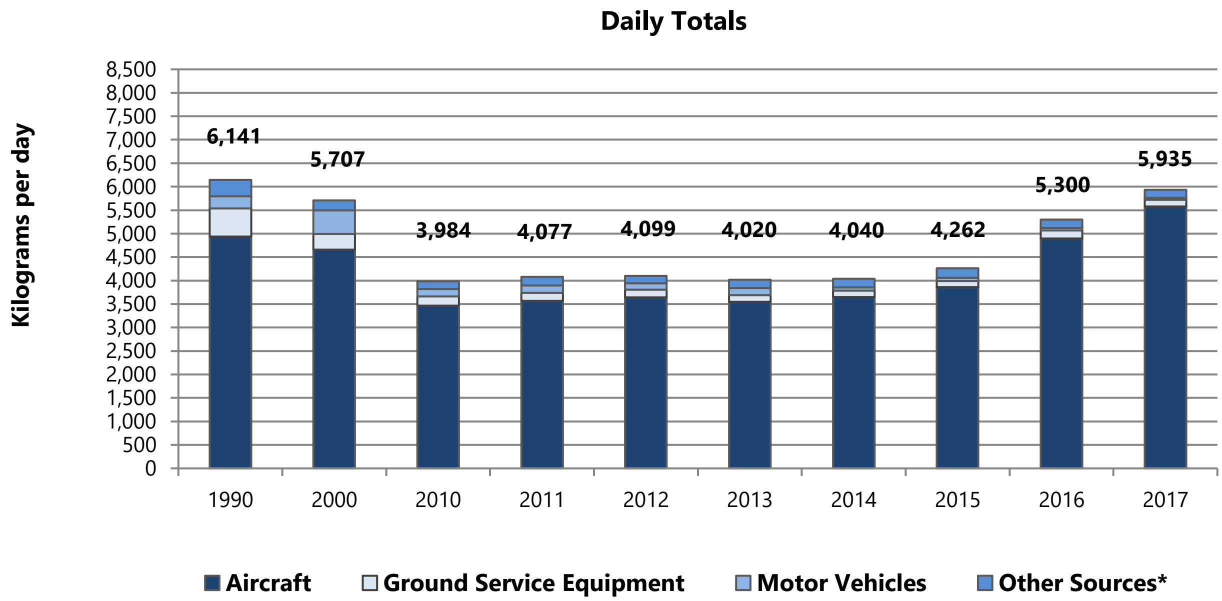
Source: Information provided from AEDT model defaults.
Notes: EPNdB – Effective perceived noise level; kg – kilograms; LTO – landings and takeoffs.

Modeled NO_x Emissions

Changes in modeled NO_x emissions at Logan Airport from 1990 through 2017 are a result of a combination of the following:

- **Calculation methodology**. For example, the 1990 inventory was prepared using the Logan Dispersion Modeling System (LDMS), the 2000 through 2015 inventories were prepared using EDMS (the version of which varied by year), and the 2016 and 2017 inventories used AEDT (two different versions). As stated in the *2016 EDR,* there are important differences in EDMS and AEDT that resulted in differences when comparing the results between the two models. The primary differences are described in the *2016 EDR* as being differences in the input data, variances in the aircraft operational characteristics, and differences in the aircraft times-in-mode (in particular those for aircraft climb out during which emissions of NO_x are greatest), emission factors, and a more robust airframe/engine database in AEDT.
- **Fleet Mix**. Changes in the fleet mix (i.e., greater use of quieter but higher NO_x emitting aircraft) are likely to continue in the future. The majority of NO_x emissions from aircraft originate from high-temperature, high-pressure reactions of atmospheric nitrogen in aircraft engines. Over time, aircraft engine technology has evolved to be more fuel-efficient, less polluting, and quieter, in large part, due to improved fuel combustion under these higher temperature and pressure conditions. This interdependency (or trade-off) between increased NO_x and better fuel efficiency, lower emissions for other pollutants (including CO_2), and less noise, is an inevitable outcome of the modernization of the commercial air carrier fleet. Aircraft engine manufacturers are continually advancing combustion technology that is designed to mitigate and reverse the tradeoffs between lower emissions, less noise, and increased NO_x.
- **Number of Aircraft Operations**. In 1990, there were 424,568 operations. By 2010, the level of operations had dropped to 352,643, and by 2017, the level of operations had recovered to 401,372.

Figure 7-4 Modeled Emissions of NO_X at Logan Airport, 1990, 2000, and 2010-2017

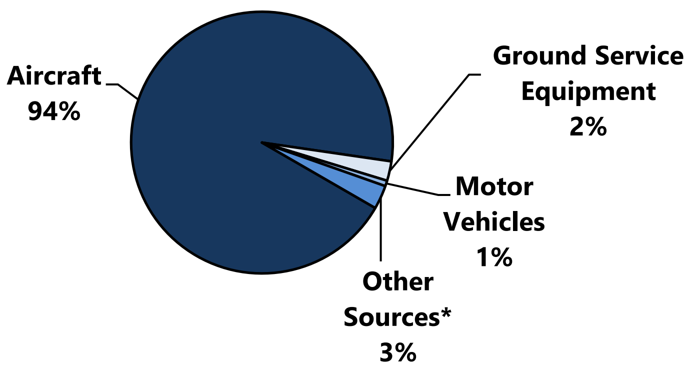


Source: Massport and KBE, 2019.
Notes: Other sources include stationary sources (e.g., Central Heating and Cooling Plant, snow melter usage, firefighter training, etc.). In 2017, aircraft-related emissions were calculated using AEDT 2d and motor vehicles were calculated using MOVES2014b.

Other findings related to the 2017 NO_X emissions inventory results include the following:

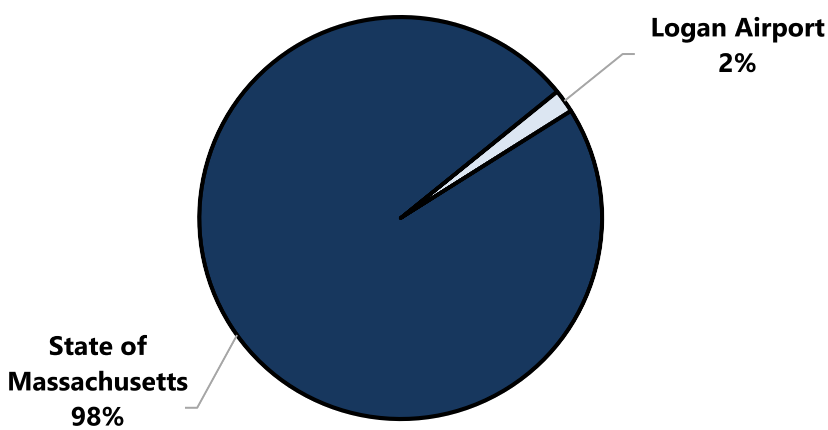
- When compared to 2016 values, total aircraft-related NO_X emissions were about 14 percent higher in 2017. The increase from 2016 to 2017 was largely due to differences in fleet mix, taxi times, and increases in total aircraft operations and partially due to the changes in model versions.
- GSE-related emissions of NO_X decreased by about 15 percent in 2017 compared to 2016, due mostly to the difference in fleet mix between the two analysis years, which subsequently affects the GSE assignment to an aircraft. The differences in fleet mix lowered the collective TIM of GSE, thus reducing the overall NO_x emissions.
- NO_X emissions from motor vehicles in 2017 decreased by approximately 28 percent from 2016 levels. This decrease was largely attributable to lower motor vehicle emission factors.
- Stationary sources showed a decrease of approximately 3 percent in NO_X emissions in 2017 compared to 2016. This was likely due to the gradual shift in consumption from diesel fuel to natural gas.

Figure 7-5 Sources of NO_x Emissions, 2017



Source: Massport and KBE, 2019.
Notes: Other sources include stationary sources (e.g., Central Heating and Cooling Plant, snow melter usage, fire training, etc.).
In 2017, aircraft-related emissions were calculated using AEDT 2d and motor vehicles were calculated using MOVES2014b.

Figure 7-6 Logan Airport 2017 NO_x Emissions Compared to Statewide Emissions



Source: Massachusetts Reasonably Available Control Technology State Implementation Plan Revision for the 2008 and 2015 Ozone National Ambient Air Quality Standards, October 18, 2018.

Table 7-8	Estimated NO_x Emissions (in kg/day) at Logan Airport, 1990, 2000, and 2010-2017[1]														
Aircraft/GSE Model:	**Logan Dispersion Modeling System (LDMS)**	**EDMS v4.03**	**EDMS v5.1.2**	**EDMS v5.1.3**				**EDMS v5.1.4.1**					**AEDT Version 2c SP2**		**AEDT Version 2d**
Motor Vehicle Model:	**MOBILE 5a**	**MOBILE 6.0**	**MOBILE 6.2.03**					**MOVES 2010b**		**MOVES 2014**	**MOVES 2014a**				**MOVES 2014b**
Year:	**1990**	**2000**	**2010**		**2011**	**2012**	**2013**		**2014**		**2015**	**2016**		**2017**	
Aircraft Sources															
Air carriers	4,554	4,202	3,031	3,037	3,128	3,154	3,090	3,158	3,245	3,245	3,470	3,912	4,476	5,098	5,100
Commuter aircraft	133	125	203	204	199	182	168	152	155	155	139	97	126	185	196
Cargo aircraft	237	284	197	197	196	192	188	188	203	203	201	224	228	224	224
General aviation	13	49	29	26	43	115	46	48	48	48	53	60	67	41	57
Total aircraft sources	4,937	4,660	3,460	3,464	3,566	3,644	3,492	3,546	3,651	3,651	3,862	4,293	4,897	5,548	5,577
Ground service equipment[2]	603	333	198	198	173	164	145	145	134	134	128	167	167	143	143
Motor Vehicles															
Ted Williams Tunnel through-traffic	N/A	26	–[3]	–[3]	–[3]	–[3]	–[3]	–[3]	–[3]	–[3]	–[3]	–[3]	–[3]	–[3]	–[3]
Parking/curbside[4]	25	52	12	12	11	10	9	16	11	6	7	6	6	4	4
On-airport vehicles	232	425	144	144	148	128	117	131	90	62	59	51	51	37	37
Total motor vehicle sources	257	503	156	156	159	137	126	147	101	68	66	57	57	41	41

Table 7-8 Estimated NO_x Emissions (in kg/day) at Logan Airport, 1990, 2000, and 2010-2017[1] (Continued)

Aircraft/GSE Model:	Logan Dispersion Modeling System (LDMS)	EDMS v4.03	EDMS v5.1.2	EDMS v5.1.3				EDMS v5.1.4.1					AEDT Version 2c SP2		AEDT Version 2d
Motor Vehicle Model:	**MOBILE 5a**	**MOBILE 6.0**	**MOBILE 6.2.03**					**MOVES 2010b**		**MOVE S 2014**	**MOVES 2014a**				**MOVES 2014b**
Year:	**1990**	**2000**	**2010**		**2011**	**2012**	**2013**		**2014**		**2015**	**2016**		**2017**	
Other Sources															
Fuel storage/handling[5]	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Miscellaneous sources[6]	344	211	166	166	179	154	182	182	187	187	206	179	179	174	174
Total other sources	344	211	166	166	179	154	182	182	187	187	206	179	179	174	174
Total Airport Sources	6,141	5,707	3,980	3,984	4,077	4,099	3,945	4,020	4,073	4,040	4,262	4,696	5,300	5,906	5,935

Source: Massport and KBE, 2019.

Notes: N/A – not available.

kg/day - kilograms per day. 1 kg/day is approximately equivalent to 0.40234 tons per year (tpy).

Years 2010, 2013, and 2016 were computed with previous years' EDMS versions to provide for a common basis of comparison. Years 2013 and 2014 were also computed with the previous years' motor vehicle emission factors models. Year 2017 was computed with current and previous versions of AEDT and MOVES.

1 See Appendix I, *Air Quality/Emissions Reduction,* for 1993 to 2009 emission inventory results.

2 Ground service equipment (GSE) emissions include auxiliary power units (APUs) as well as vehicles and equipment converted to alternative fuels.

3 Due to the new roadway configuration and opening of the Ted Williams Tunnel there was no Ted Williams Tunnel through-traffic at Logan Airport beginning in 2003.

4 Parking/curbside data is based on vehicle miles traveled (VMT) analysis.

5 Fuel storage/handling facilities are not a source of NO_x emissions.

6 Includes the Central Heating and Cooling Plant, emergency electricity generation, snow melter usage, and other stationary sources.

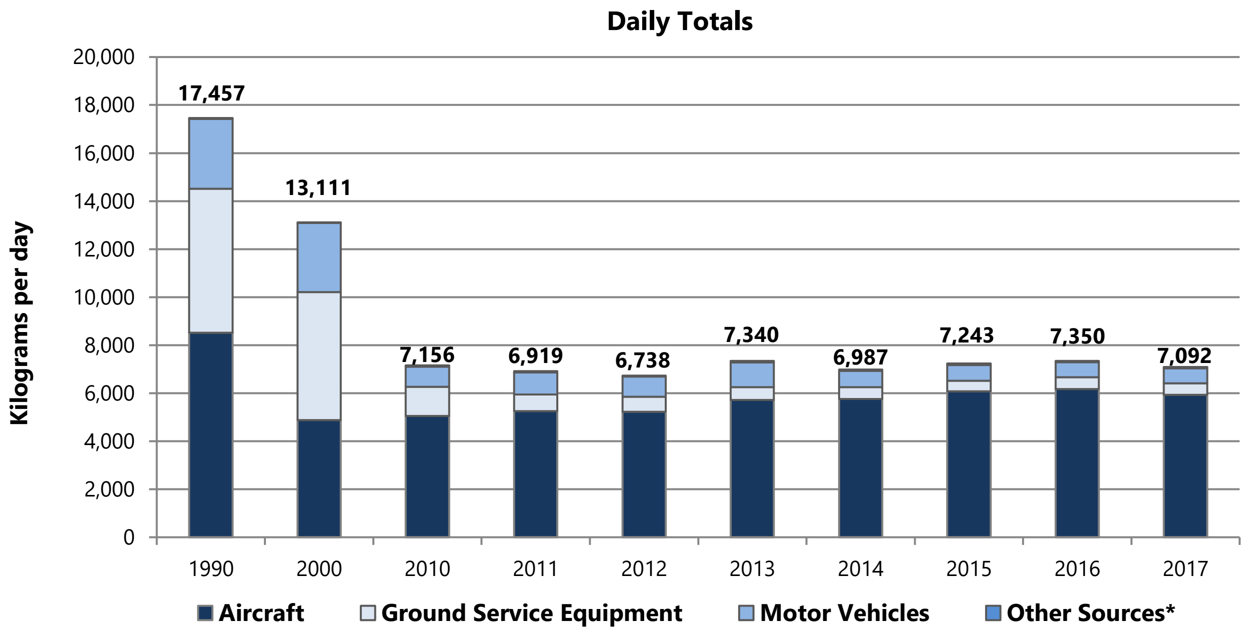
Carbon Monoxide (CO)

Total CO emissions at Logan Airport in 2017 were 2,872 tpy (7,139 kg/day), about 3 percent lower than 2016 levels. **Figure 7-7** shows the continued long-term downward trend (about 59 percent overall reduction from 1990 levels) in CO emissions associated with Airport activities. **Table 7-9** also shows the breakdown of these emissions, by source category, for the years 1990, 2000, and 2010 to 2017. Other notable findings of the CO emissions inventory include:

- Aircraft-related CO emissions decreased in 2017 by about 4 percent compared to 2016 levels, mostly due to the differences between AEDT 2d and 2c SP2 as shown previously in **Table 7-4**.
- GSE-related CO emissions decreased by approximately 2 percent in 2017 compared to 2016, due mostly to the change in fleet mix and overall decrease in run-time as a result.
- CO emissions from motor vehicles decreased in 2017 by approximately 2 percent from 2016 levels. This decrease was attributable mostly to lower motor vehicle emission factors.
- Stationary sources showed an increase in CO emissions in 2017 by approximately 4 percent from 2016, largely due to an increase in natural gas consumption in 2017 from boilers and snow melters.

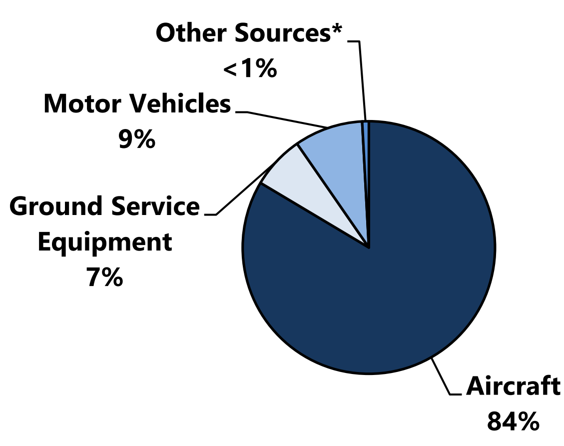
As shown in **Figure 7-8**, for 2017, aircraft emissions continued to represent the largest source (84 percent) of CO at Logan Airport, followed by motor vehicles (9 percent), GSE (7 percent), and other sources (less than 1 percent).

Figure 7-7 Modeled Emissions of CO at Logan Airport, 1990, 2000, and 2010-2017



Source: Massport and KBE, 2019.
Notes: Other stationary sources are not visible on the graph as they make up less than 1 percent of the total.
In 2017, aircraft-related emissions were calculated using AEDT 2d and motor vehicles were calculated using MOVES2014b.

Figure 7-8 Sources of CO Emissions, 2017



Source: Massport and KBE, 2019.
Notes: Other sources include stationary sources (e.g., Central Heating and Cooling Plant, snow melter usage, fire training, etc.) and fueling sources.
In 2017, aircraft-related emissions were calculated using AEDT 2d and motor vehicles were calculated using MOVES2014b.

Table 7-9 Estimated CO Emissions (in kg/day) at Logan Airport, 1990, 2000, and 2010-2017[1]

Aircraft/GSE Model:	**Logan Dispersion Modeling System (LDMS)**	**EDMS v4.03**	**EDMS v5.1.2**	**EDMS v5.1.3**				**EDMS v5.1.4.1**				**AEDT Version 2c SP2**			**AEDT Version 2d**
Motor Vehicle Model:	**MOBIL E 5a**	**MOBILE 6.0**	**MOBILE 6.2.03**					**MOVES 2010b**		**MOVES 2014**	**MOVES 2014a**				**MOVES 2014b**
Year:	**1990**	**2000**	**2010**		**2011**	**2012**	**2013**		**2014**		**2015**	**2016**		**2017**	
Aircraft Sources															
Air carriers	6,613	2,994	2,531	2,531	2,592	2,816	3,320	3,323	3,486	3,486	3,729	3,879	3,653	3,736	3,740
Commuter aircraft	977	1,188	2,629	2,086	2,042	1,928	1,978	1,907	1,795	1,795	1,826	1,737	1,998	1,905	1,525
Cargo aircraft	576	400	248	259	246	183	155	155	164	164	167	192	201	192	192
General aviation	352	295	177	173	370	304	345	334	319	319	353	336	314	526	470
Total aircraft sources	8,518	4,877	5,585	5,049	5,250	5,232	5,798	5,719	5,764	5,764	6,075	6,144	6,166	6,359	5,926
Ground service equipment[2]	6,001	5,335	1,222	1,222	694	618	533	533	484	484	442	493	493	482	483
Motor Vehicles															
Ted Williams Tunnel through-traffic	N/A	133	–[3]	–[3]	–[3]	–[3]	–[3]	–[3]	–[3]	–[3]	–[3]	–[3]	–[3]	–[3]	–[3]
Parking/curbside[4]	1,218	495	106	106	110	104	104	94	57	51	28	37	37	32	32
On-airport vehicles	1,689	2,245	726	726	806	737	742	935	591	630	630	596	596	592	592
Total motor vehicle sources	2,907	2,873	832	832	916	840	846	1,029	648	681	658	633	633	623	623

Table 7-9 Estimated CO Emissions (in kg/day) at Logan Airport, 1990, 2000, and 2010-2017[1] (Continued)

Aircraft/GSE Model:	Logan Dispersion Modeling System (LDMS)	EDMS v4.03	EDMS v5.1.2	EDMS v5.1.3				EDMS v5.1.4.1				AEDT Version 2c SP2			
Motor Vehicle Model:	**MOBILE 5a**	**MOBILE 6.0**	**MOBILE 6.2.03**					**MOVES 2010b**		**MOVES 2014**	**MOVES 2014a**				**MOVES 2014b**
Year:	**1990**	**2000**	**2010**		**2011**	**2012**	**2013**		**2014**		**2015**	**2016**		**2017**	
Other Sources															
Fuel storage/handling[5]	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Miscellaneous sources[6]	31	27	53	53	59	48	59	59	58	58	68	58	58	60	60
Total other sources	31	27	53	53	59	48	59	59	58	58	68	58	58	60	60
Total Airport Sources	17,457	13,112	7,962	7,156	6,919	6,738	7,236	7,340	6,954	6,987	7,243	7,328	7,350	7,524	7,092

Source: Massport and KBE, 2019.

Notes: N/A – not available.

Years 2010 and 2013 were computed with previous years' EDMS versions to provide for a common basis of comparison. Years 2013 and 2014 were also computed with the previous years' motor vehicle emission factors models. Year 2017 was computed with current and previous versions of AEDT and MOVES.

1 See Appendix I, *Air Quality/Emissions Reduction,* for 1993 to 2009 emission inventory results.

2 Ground service equipment (GSE) emissions include aircraft auxiliary power units (APUs) as well as vehicles and equipment converted to alternative fuels.

3 Due to the new roadway configuration and opening of the Ted Williams Tunnel, there was no Ted Williams Tunnel through-traffic at Logan Airport beginning in 2003.

4 Parking/curbside is based on vehicle miles traveled (VMT) analysis.

5 Fuel storage/handling facilities are not a source of NO_x emissions.

6 Includes the Central Heating and Cooling Plant, emergency electricity generation, snow melter usage, and other stationary sources.

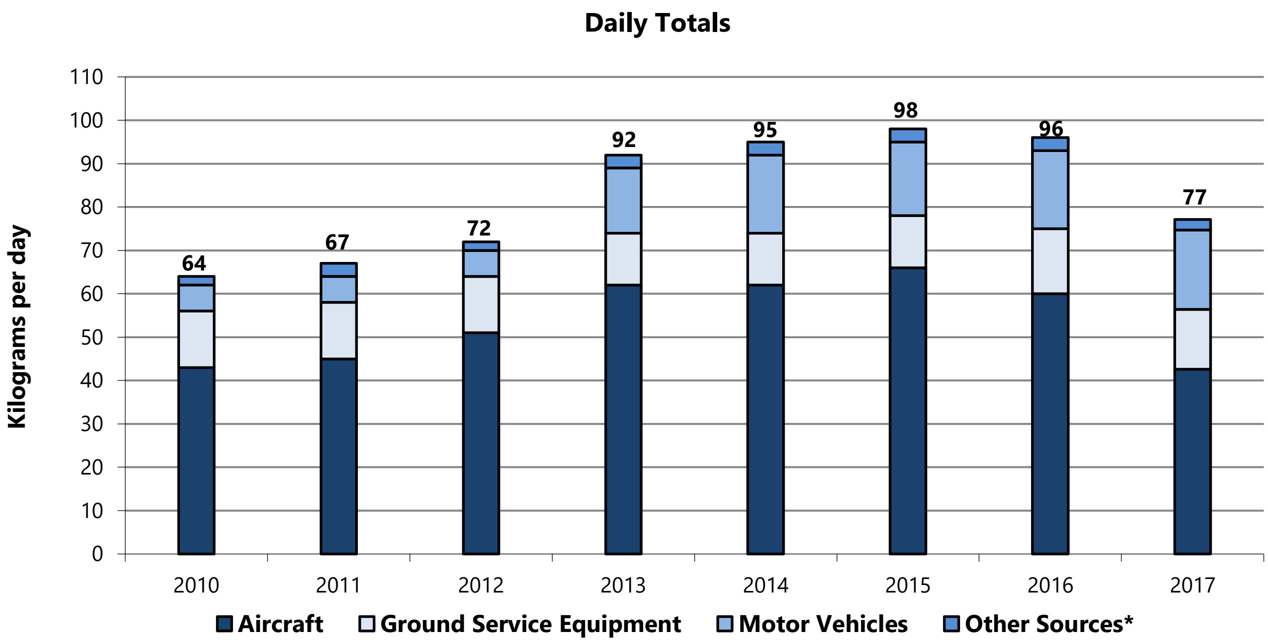
Particulate Matter

Estimated $PM_{10}/PM_{2.5}$ emissions at Logan Airport in 2017 are presented in **Table 7-10**. These results show total emissions of 31 tpy (77 kg/day), or about 20 percent lower than 2016 levels. Explanations of these results and other key findings include the following:

- Estimated aircraft-related $PM_{10}/PM_{2.5}$ emissions decreased by about 29 percent in 2017 compared to 2016 levels, due mostly to differences in fleet mix and therefore corresponding changes in emission factors.
- $PM_{10}/PM_{2.5}$ associated with GSE-related emissions decreased by about 9 percent in 2017 when compared to 2016, largely due to the change in fleet mix which decreased aircraft-based GSE operating times.
- $PM_{10}/PM_{2.5}$ emissions from motor vehicles increased by about 2 percent in 2017 when compared to 2016 levels, primarily attributable to an increase in motor vehicle volumes which was slightly offset by lower motor vehicle emission factors.
- Stationary source emissions of $PM_{10}/PM_{2.5}$ decreased by about 9 percent in 2017 compared to 2016. This was likely attributable to a gradual transition from diesel fuel to natural gas.

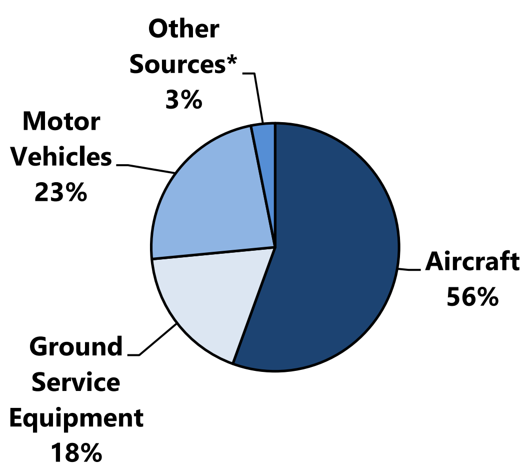
As shown in **Figures 7-9** and **7-10**, aircraft emissions represent the largest source (56 percent) of $PM_{10}/PM_{2.5}$ at Logan Airport, followed by motor vehicles (23 percent), GSE (18 percent), and other sources, such as the Central Heating and Cooling Plant, snow melter usage, and fire training (3 percent).

Figure 7-9 Modeled Emissions of $PM_{10}/PM_{2.5}$ at Logan Airport, 2010-2017



Source: Massport and KBE, 2019.
Notes: 2005 (not shown) was the first-year particulate matter (PM) was included in the EDR/ESPR emission inventories.
The increase in emissions from 2012 to 2013 were primarily due to changes in the EDMS and MOVES computer models.
In 2017, aircraft-related emissions were calculated using AEDT 2d and motor vehicles were calculated using MOVES2014b.
Other sources include stationary sources (e.g., Central Heating and Cooling Plant, snow melter usage, fire training, etc.).

Figure 7-10 Sources of $PM_{10}/PM_{2.5}$ Emissions, 2017



Source: Massport and KBE, 2019.
Note: Other sources include stationary sources (e.g., Central Heating and Cooling Plant, snow melter usage, fire training, etc.).
In 2017, aircraft-related emissions were calculated using AEDT 2d and motor vehicles were calculated using MOVES2014b.

Table 7-10 Estimated $PM_{10}/PM_{2.5}$ Emissions (in kg/day) at Logan Airport, 2010-2017[1]

Aircraft/GSE Model:	EDMS v5.1.2	EDMS v5.1.3				EDMS v5.1.4.1					AEDT Version 2c SP2		AEDT 2d
Motor Vehicle Model:	**MOBILE 6.2.03**					**MOVES 2010b**		**MOVES 2014**	**MOVES 2014a**				**MOVES 2014b**
Year:	**2010**		**2011**	**2012**	**2013**		**2014**		**2015**	**2016**		**2017**	
Aircraft Sources													
Air carriers	34	34	35	43	41	48	48	48	53	57	52	36	36
Commuter aircraft	4	4	3	2	2	7	7	7	7	6	4	2	3
Cargo aircraft	3	3	3	3	2	3	3	3	3	3	2	1	1
General aviation	2	2	4	3	3	4	4	4	4	4	2	3	2
Total aircraft sources	43	43	45	51	48	62	62	62	66	70	60	42	43
Ground service equipment[2]	13	13	13	13	12	12	12	12	12	15	15	14	14
Motor Vehicles													
Parking/curbside[3]	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
On-airport vehicles	6	6	6	6	6	14	14	18	16	17	17	18	18
Total motor vehicle sources	6	6	6	6	6	15	14	18	17	18	18	18	18
Other Sources													
Fuel storage/handling[4]	0	0	0	0	0	0	0	0	0	0	0	0	0
Miscellaneous sources[5]	2	2	3	2	3	3	3	3	3	3	3	2	2
Total other sources	2	2	3	2	3	3	3	3	3	3	3	2	2
Total Airport Sources	64	64	67	72	69	92	91	95	98	106	96	77	77

Source: Massport and KBE, 2019.

Notes: kg/day - kilograms per day. 1 kg/day is approximately equivalent to 0.40234 tons per year (tpy); PM - particulate matter.
Years 2010 and 2013 were computed with previous years' EDMS versions to provide for a common basis of comparison. Years 2013 and 2014 were also computed with the previous years' motor vehicle emission factors models. Year 2017 was computed with current and previous versions of AEDT and MOVES.

1 It is assumed that all PM are less than 2.5 microns in diameter ($PM_{2.5}$). See Appendix I, *Air Quality/Emissions Reduction,* for 2005 to 2009 emission inventory results.

2 Ground service equipment (GSE) emissions include auxiliary power units (APUs) as well as vehicles and equipment converted to alternative fuels.

3 Parking/curbside is based on vehicle miles traveled (VMT) analysis.

4 Fuel storage and handling facilities are not sources of PM emissions.

5 Includes the Central Heating and Cooling Plant, emergency electricity generation, fire training, snow melters, and other stationary sources.

Ultrafine Particles (UFPs)

Within the field of air quality, airborne particles are collectively categorized as PMs and subdivided into size categories based on their diameters. These divisions are total suspended particles (TSP) with diameters ranging from 2.5 to 40 micrometers (μm), course particles (PM_{10}) with diameters ranging from 2.5 to 10 μm, fine particles ($PM_{2.5}$) with diameters less than 2.5 μm, and UFPs with diameters less than 0.1 μm. The majority of these particles originate from the exhaust gases generated by fossil fuel-powered engines and other high-temperature combustion sources including aircraft.

Under the CAA, EPA has established NAAQS for six criteria air pollutants including PM_{10} and $PM_{2.5}$. Outdoor concentrations within EPA standards are considered safe for the public. Presently, UFPs (by themselves) are not regulated ambient pollutants. UFPs cannot be considered part of $PM_{2.5}$ because $PM_{2.5}$ regulates by mass, and UFPs have a comparatively negligible mass. Any eventual UFP regulation would be regulated by concentration.

EPA has begun to reconsider a NAAQS for UFPs due to their unique physical attributes and potential human health hazards. Under CAA, reassessments of the NAAQS for $PM_{10/2.5}$ are underway and should be finalized by 2022.[10] This reassessment would be the next opportunity to consider including UFPs among the criteria pollutants. However, the link between UFP exposure and adverse health effects, although suggestive, may not rise to the level of promulgating a new NAAQS at this time.

With respect to airport-related UFP studies, the collection of materials is limited. However, recent studies have focused on understanding UFP measurements in the vicinity of airports. Studies conducted at Zurich Airport in Switzerland and Heathrow Airport in London have demonstrated that UFP dispersion is highly dependent on wind speed and direction at the airport with UFP particle concentrations being on the order of 10 times higher when measured downwind of the airport.[11,12] A study conducted at Brussels Airport demonstrated the UFP emissions from the airport can significantly impact concentrations up to 7 kilometers (4.3 miles) away from the source.[13] These studies have begun to explain the dispersion characteristics of UFPs from airports, but specific health studies to assess impacts of UFPs from airport sources have yet to be conducted. Massport is supportive of and is following a research effort undertaken by the FAA Center of Excellence for Alternative Jet Fuels and Environment, Aviation Sustainability Center (ASCENT)[14] attempting to measure UFP emissions related to aircraft and other sources. In July 2017, the research project measured and modeled UFPs for one runway end at Logan Airport. The study is ongoing and will reflect both arrival and departure flight paths. Massport will report on the findings of the study in the next EDR, if available.

Most recently, Massport is cooperating with Boston University, Tufts University, and other researchers in identifying aircraft-specific related UFPs in an urban environment with non-Airport related sources. This

10 U.S. Environmental Protection Agency. December 2016. Final Integrated Review Plan for the Ambient Air Quality Standards for Particulate Matter. https://www3.epa.gov/ttn/naaqs/standards/pm/data/201612-final-integrated-review-plan.pdf.

11 Fleuti, E., Maraini, S., Bieri, L., 2017. *Ultrafine Particle Measurements at Zurich Airport.* Flughafen Zurich AG.

12 Masiol, M., Harrison, R. M., Vu, T. V., and Beddows, D. C. S. *Sources of Submicrometre Particles Near a Major International Airport,* Atmos. Chem. Phys. Discuss., https://doi.org/10.5194/acp-2017-150, in review, 2017.

13 Peters, J., Berghmans, P., and Frijns, E. 2016. *Ultrafine Particles and Black Carbon monitoring in the surroundings of Brussels Airport.* Brussels Environmental Agency.

14 FAA Center of Excellence for Alternative Jet Fuels & Environment. https://ascent.aero/.

research is underway in the East Boston area and Massport continues to contribute by providing airport operational and other pertinent data.

Emissions Inventory in the Future Planning Horizon

In 2019, Massport developed a long-range forecast for Logan Airport for the Future Planning Horizon (see Chapter 2, *Activity Levels*). The Future Planning Horizon assumes an air passenger activity level of 50 million annual air passengers, which is anticipated to occur in the next 10 to 15 years. Emissions of VOCs, CO, NO_x, $PM_{10}/PM_{2.5}$, and GHGs were modeled for the Future Planning Horizon.

The number of aircraft operations forecasted for the future condition (486,364 operations) is greater than in 2017 (401,371 operations). However, this forecast is less than the level of total aircraft operations in 2000 (487,996 operations) and still well below the peak of 507,449 in 1998. These aircraft operations forecasts, along with future Airport activity assumptions pertaining to airfield operating conditions, aircraft fleet mix, GSE and APU usage, and fuel throughput volumes, were used to calculate the future emissions inventory. Although there are projected increases in aircraft emissions due to increased flights, these are partially offset by the decrease in emissions from GSE and motor vehicles, primarily due to anticipated fuel-efficient motor vehicles and the Airport's commitment to convert commercially-available GSE to eGSE by the end of 2027. In addition, the future emissions inventory represents a conservative analysis. Actual future emissions are anticipated to be lower than the predicted values because this forecast does not assume emissions reduction technology advancements.

Future Fleet Mix, VMT, and Operations Assumptions

There are several limitations on the predictive ability of air quality models relating to years as distant as 10 to 15 years out. For example, the FAA's AEDT model used to conduct the aircraft and GSE analyses is often updated by FAA but these updates do not account for future-year technological changes. The EDRs and ESPRs update assumptions and technological advances as they are available. The modeling used to calculate the future emissions inventory makes the following assumptions:

- As with the 2017 emissions inventory, the most recent version, AEDT 2d, was used to compute the future Logan Airport emissions inventory. While current aircraft and motor vehicle engine technologies are likely to change, become more efficient, and use alternative fuels not used currently, these changes cannot feasibly be accounted for, and thus are not included in the model. Similarly, the modeled aircraft reflect current technologies and cannot adequately characterize the low-emissions profiles of certain developing engine technologies. Thus, the predicted emissions represent a conservative estimate (likely over-estimate) of future conditions.
- LTOs are forecasted to increase from 200,686 in 2017 to 243,182, with overall air carrier LTOs increasing from 140,053 to 186,510, commuter LTOs decreasing from 41,676 to 36,824, air cargo LTOs increasing from 3,366 to 4,005, and GA increasing from 15,590 to 15,843. **Table I-4** in Appendix I, *Air Quality/Emissions Reduction,* contains the input data that were used, including aircraft types, engines, LTOs, and assumed aircraft taxi/delay times.

- The estimation of APU emissions was based on data from the 2017 on-site GSE TIM survey, as well as forecasted future aircraft fleet operations. All GSE were assumed to be converted to eGSE by the Future Planning Horizon.
- Aircraft taxi times for the Future Planning Horizon were developed from the recent Boston Logan Runway Incursion Mitigation (RIM) study and FAA's ASPM database, which provides the use of the Airport for each of the main runway configurations. The average taxi time forecasted for the Future Planning Horizon is approximately one minute less than the times reported for 2017.
- As with 2017, motor vehicle emission factors for the Future Planning Horizon were obtained from the most recent version of EPA's MOVES model (MOVES2014b) and were combined with MassDEP-recommended motor vehicle fleet mix data, operating conditions, and other Massachusetts specific input parameters. The MOVES model reflects the continuous reduction in motor vehicle emissions over time. The MOVES input/output files are included in Appendix I*, Air Quality/Emissions Reduction*.
- Emissions associated with fuel storage and handling, the Central Heating and Cooling Plant, snow melters, emergency generators, space heaters, and fire training at Logan Airport are based largely on fuel throughput, and are expected to become more fuel-efficient, less fuel-dependent, and emit fewer emissions in the Future Planning Horizon. Emissions from boilers, emergency generators, and space heaters were estimated using the average fuel throughput for the past five years, combined with the anticipated increase in terminal building square footage. Emissions from snow melters and fire training were also based on the past five-year average usage. In addition, it was assumed that snow melters would have a 50-percent shift in usage from diesel to natural gas by the Future Planning Horizon. The same emission factors used in 2017 were also assumed for the future condition. In addition, the near-term upgrading and replacement of the heating plant boilers are also expected to reduce emissions beyond what is predicted.

Future Planning Horizon Emissions Inventory Results

Due to the conservative nature of the modeling assumptions, the results of the future emissions inventory, which are shown in **Table 7-11**, should be considered reasonable, but may be conservatively high, since the calculations are based on currently known information. As such, the outcome is subject to refinements as more accurate emissions data become available in the future and will be updated with future ESPRs.

Changes in emissions are a function of the number of aircraft operations, fleet mix, taxi times, GSE emission factors, motor vehicle volumes and emission factors, stationary source fuel usage, and other sources. In some cases, these data result in differing effects. For example, taxi times influence aircraft VOC and CO; the number of operations largely influence NO_x; and GSE serving the aircraft fleet influence $PM_{10}/PM_{2.5}$. The following bullets summarize the future emissions findings:

- Total modeled emissions of VOCs are expected to be about 8 percent lower than in 2017 and 34 percent lower than in 2000. This decrease is mostly attributable to the change in aircraft fleet mix, anticipated decreases in aircraft taxi times, conversion of all GSE to eGSE, and lower motor vehicle emission factors in the Future Planning Horizon.

- Total modeled emissions of NO_x are predicted to be about 37 percent higher than in 2017 and 43 percent higher than in 2000.
  - The increase from 2017 is almost entirely a result of the changing aircraft fleet (i.e., greater use of quieter but higher NO_x emitting aircraft) and the forecasted increase in operations.
  - The increases from 2000 are primarily due to a combination of fleet mix changes, increase in annual operations, and differences in EDMS and AEDT models.
  - The current projections for the future do not incorporate technological innovations that are likely to be in effect at that time, including the introduction of aircraft engines, which will be more efficient, cleaner, and quieter. Therefore, with more operations and higher-emitting engines in the current database, the predicted NO_x emissions from aircraft are likely to be conservatively high.
  - The majority of NO_x emissions from aircraft originate from high-temperature, high-pressure reactions of atmospheric nitrogen in aircraft engines. Over time, aircraft engine technology has evolved to be more fuel-efficient, less polluting, and quieter, in large part, due to improved fuel combustion under these higher temperature and pressure conditions. This interdependency (or trade-off) between increased NO_x and better fuel efficiency, lower emissions for other pollutants (including CO_2), and less noise, is an inevitable outcome of the modernization of the commercial air carrier fleet. Aircraft engine manufactures are continually advancing combustion technology that is designed to moderate the production of NO_x.
  - As previously discussed, VOCs and NO_x are the two main pollutants involved in ozone formation and in "VOC-Limited" areas such as Boston, NO_x emissions play a lesser role in ozone formation than VOCs. Or stated more directly, ozone formation is impacted more by VOCs than by NO_x. Therefore, the forecasted increases in NO_x emissions associated with Logan Airport must be interpreted with the long-term decrease in VOC emissions; the relationship between increasing emissions of NO_x and decreasing emissions of VOCs represents a potential moderation to the ozone-forming potential of increasing NO_x emissions.
- Total modeled future emissions of CO are predicted to be about 2 percent lower compared to 2017 and 47 percent lower than in 2000. This overall reduction is primarily due to anticipated fuel-efficient motor vehicles and the Airport's commitment of converting all GSE to eGSE by this time period.
- Total modeled future emissions of $PM_{10}/PM_{2.5}$ are expected to be about 10 percent lower than 2005 levels and 3 percent lower than in 2017. This overall reduction since 2005 is primarily attributable to lower emitting motor vehicles and electrification of GSE over this timeframe.

The estimated emission totals for the Future Planning Horizon are expected to be measurably less for all pollutants than the values reported in this *2017 ESPR*, with the exception of NO_x, due to the characteristics of the aircraft fleet, even with the increase in operations. The current version of AEDT, which was used to calculate the future emissions inventory, does not reflect the significant design and operational improvements in aircraft engine technologies, alternative fuels, and aircraft operational measures, which will lead to lower fuel use, improved combustion efficiencies, and lower emissions.

Table 7-11 Future Planning Horizon Emission Estimates (in kg/day) at Logan Airport

Source Categories	VOC		NO_x		CO		$PM_{10}/PM_{2.5}$	
	2017	**Future**	**2017**	**Future**	**2017**	**Future**	**2017**	**Future**
Aircraft Sources[1]								
Air carriers	517	489	5,100	7,235	3,740	5,336	36	45
Commuter aircraft	77	47	196	356	1,525	380	3	3
Cargo aircraft	50	67	224	243	192	265	1	1
General aviation	134	71	57	28	470	613	2	1
Total aircraft sources	778	673	5,577	7,863	5,926	6,593	43	50
Ground service equipment[2]	22	4	143	85	483	45	14	8
Motor Vehicles								
Parking/curbside[3]	3	2	4	1	32	5	<1	<1
On-airport vehicles	26	11	37	5	592	221	18	14
Total motor vehicle sources	29	13	41	6	623	226	18	14
Other Sources								
Fuel storage/handling[4]	439	482	0	<1	0	<1	0	<1
Miscellaneous sources[5]	5	6	174	198	60	66	2	2
Total other sources	444	488	174	198	60	66	2	2
Total Airport Sources	**1,273**	**1,178**	**5,935**	**8,151**	**7,092**	**6,930**	**77**	**74**
Percent Change	**(7.5%)**		**37.3%**		**(2.3%)**		**(2.9%)**	

Source: Massport and KBE, 2019.

Notes: kg/day is approximately equivalent to 0.40234 tons per year (tpy). Year 2017 and Future Planning Horizon were computed with current versions of AEDT and MOVES. Totals may not add exactly due to rounding.

CO – carbon monoxide; NO_X – oxides of nitrogen; PM – particulate matter; VOC – volatile organic compound.

1 Calculations for the Future Planning Horizon are based on taxi times based on Boston Logan Runway Incursion Mitigation (RIM) study and the Federal Aviation Administration's (FAA's) Aviation System Performance Metrics (ASPM).

2 2017 ground service equipment (GSE) emissions include aircraft auxiliary power units (APUs) as well as vehicles and equipment converted to alternative fuels. The Future Planning Horizon assumes all electric GSE (excluding APUs). APU run times are based on 2017 on-site GSE time in-mode survey and Future Planning Horizon fleet mix.

3 Parking/curbside data is based on vehicle miles traveled (VMT) analysis.

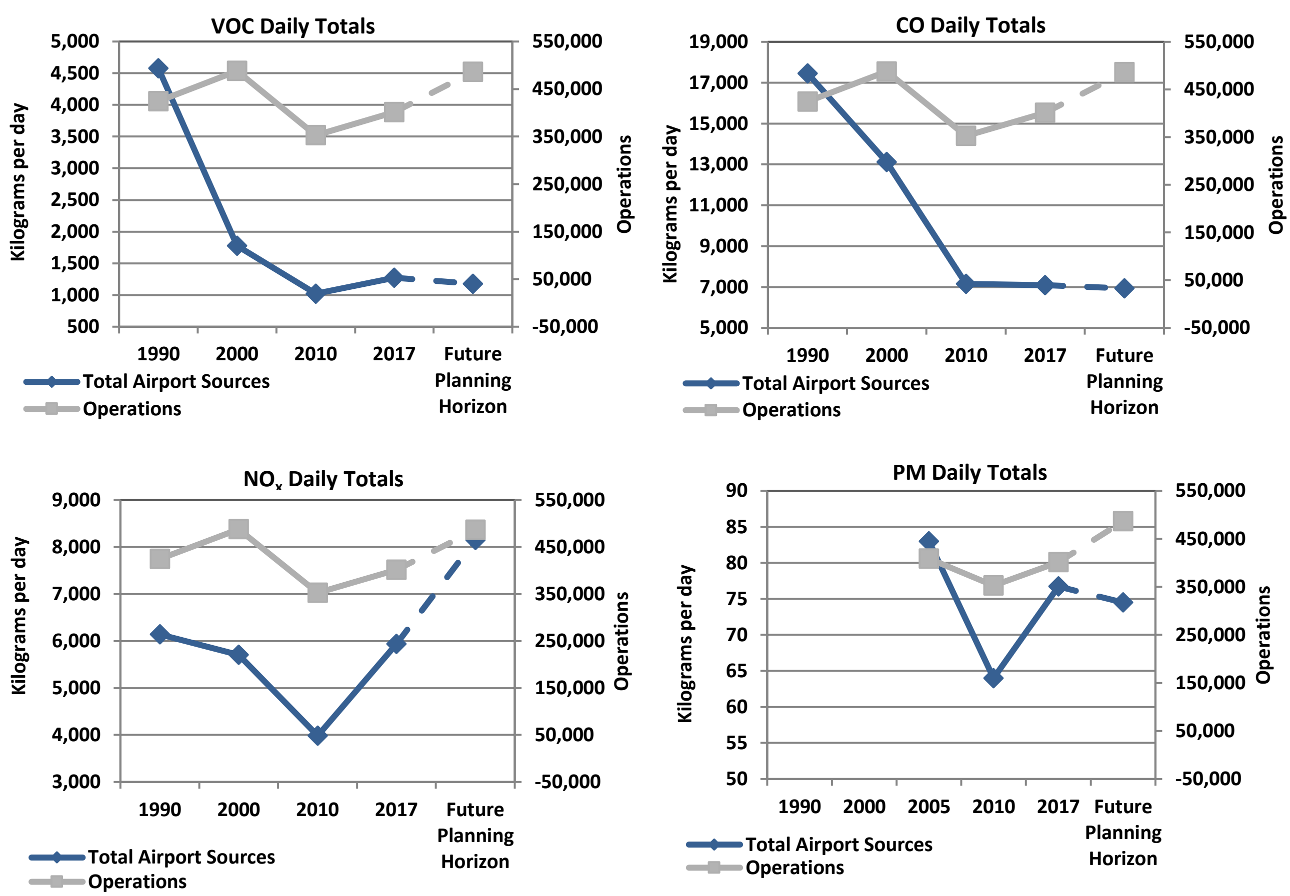
4 Fuel storage/handling facilities only emit VOC emissions.

5 Includes the Central Heating and Cooling Plant, emergency generators, space heaters, snow melters, and fire training activities.

Historical Context and Trends

This section provides a summary of the Logan Airport long-range emissions levels for VOCs, CO, NO_x, and $PM_{10}/PM_{2.5}$ from 1990 to the Future Planning Horizon. As shown, long-range emissions levels at Logan Airport have decreased since 1990, except for NO_x. Decreases in emissions are due to improvements in aircraft and motor vehicle engine combustion technologies, as well as improvements to the Airport such as the Logan Airside Improvements Project. Increases in NO_x emissions are predominantly due to an increase in aircraft operations (424,568 in 1990 and 486,364 in the future), as well as the AEDT model, resulting in higher NO_x emissions compared to the legacy tool EDMS. The emission trends for VOCs, NO_x, CO, and PM from 1990 to the Future Planning Horizon are shown in **Figure 7-11** and operational levels at the Airport are also shown for comparative purposes.

Figure 7-11 Emissions Trends of VOCs, NO_x, CO, and PM at Logan Airport, 1990-Future Planning Horizon[1]



Source: Massport and KBE, 2019.

Notes: The dashed lines represent projected values.

CO – carbon monoxide; NO_X – oxides of nitrogen; PM – particulate matter; VOC – volatile organic compound.

1 PM emissions were not estimated until 2005.

Greenhouse Gas (GHG) Assessment

GHGs are known to contribute to climate change. In April 2009, the EPA issued a proposed finding that GHGs also contribute to air pollution that may endanger public health or welfare. This action has laid the initial legal groundwork for the regulation of GHG emissions nationwide under the CAA, although currently there are no specific U.S. laws or regulations that call for the regulation of GHGs for airports directly.[15] Current estimates of the contributions of aviation-related GHG emissions to man-made totals range from about 2 to 4 percent world-wide, and approximately 3 percent in the U.S.[16,17]

In May 2010, the Massachusetts Executive Office of Energy and Environmental Affairs (EEA) revised the *Massachusetts Environmental Policy Act (MEPA) Greenhouse Gas Emissions Policy and Protocol*.[18] Under the revised policy, certain projects subject to review under MEPA (though not annual EDR/ESPR filings) are required to:

- Quantify GHG emissions generated by a proposed project; and
- Identify measures to avoid, minimize, or mitigate such emissions.[19]

With respect to this *2017 ESPR* GHG emissions inventory,[20] the following information is noteworthy:

- Although the *2017 ESPR* is not subject to the MEPA GHG policy (because it does not propose any discrete projects), since the *2007 EDR,* Massport has continued to voluntarily prepare an inventory of GHG emissions both directly and indirectly associated with the Airport.
- The emission source categories in the *2017 ESPR* satisfy MEPA's requirement to analyze the environmental impacts of direct and indirect mobile and stationary source emissions.

---

15 GHG emission reduction measures have been adopted by the EPA for new aircraft engines, but these regulations do not apply directly to airports.

16 Intergovernmental Panel on Climate Change. November 2014. *Fifth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC).* The Sixth Assessment Report of the IPCC is currently in development and will be finalized in July 2021.

17 U.S. Governmental Accountability Office (GAO), Aviation and the Environment, NextGen and Research and Development Are Keys to Reducing Emissions and Their Impact on Health and Climate, May 6, 2008.

18 Massachusetts Executive Office of Energy and Environmental Affairs (EEA). Effective May 5, 2010. Revised Massachusetts Environmental Policy (MEPA) Greenhouse Gas Emissions Policy and Protocol.

19 GHGs are comprised primarily of carbon dioxide (CO_2), methane (CH_4), nitrous oxides (N_2O), and three groups of fluorinated gases (i.e., sulfur hexafluoride [SF_6], hydrofluorocarbons [HFCs], and perfluorocarbons [PFCs]). GHG emission sources associated with airports are generally limited to CO_2, CH_4, and N_2O.

20 This ESPR greenhouse gas (GHG) inventory is one of three that Massport prepares annually; however, the other two comprise only stationary sources of GHGs and are filed with MassDEP and the EPA respectively. These reports are for Massport-owned-and-operated equipment only, and do not cover any tenant owned/operated-equipment or facilities.

- Consistent with previous years, the 2017 GHG emissions inventory was prepared following methodological guidance by the Transportation Research Board's (TRB) Airport Cooperative Research Program (ACRP).[21] The inventory assigns GHG emissions based on ownership or control (whether they are controlled by Massport, the airlines or other airport tenants, or the general public).
- The 2017 GHG emissions inventory includes aircraft operations within the ground-based taxi-idle/delay mode and up to the top of the 3,000-foot LTO cycle. For estimating GHGs, the LTO cycle (up to 3,000 feet) uses the default mixing height in AEDT. GHG emissions associated with GSE/APU, motor vehicles, a variety of stationary sources, and electricity usage were also included.
- Massport has direct ownership or control over a small percentage of the GHG emission sources (which include Massport fleet vehicles, stationary sources, and electrical consumption within Massport buildings). The vast majority of the emission sources are owned or controlled by the airlines, other airport tenants (such as rental car companies), and the general public (such as passenger motor vehicles).
- Massport also prepares two other GHG emissions inventories for stationary sources at Logan Airport:
    - A GHG emissions inventory for the MassDEP GHG Emissions Reporting Program for those sources meeting the criteria for Category 1 and Scope 1 (only those sources under the direct ownership and control of Massport);[22,23] and
    - An EPA Greenhouse Gas Summary Report.[24]

This ESPR analysis followed EEA guidelines and uses widely-accepted emission factors that are considered appropriate for airports, including International Organization for Standardization (ISO) New England electricity-based values. The analysis is also consistent with ACRP guidance.

For consistency and comparative purposes, GHG emissions are segregated by ownership and control into categories. These three categories (listed in **Table 7-12**) are further characterized by the degree of control that Massport has over the GHG emission sources.

- **Category 1: Massport Owned** – By definition, these GHG emissions arise from sources that are owned and controlled by the reporting entity (in this case, Massport). More precisely, Category 1 typically represents sources which are owned by the entity, or sources which are not owned by the entity, but over which the entity can exert control. At Logan Airport, these sources include Massport-owned and controlled stationary sources (boilers, generators, etc.), fleet vehicles, and purchased electricity. On-Airport ground transportation and off-Airport employee vehicle trips are also included as Category 1 emissions as they are partly controlled by the Airport.

21 Transportation Research Board, Airport Cooperative Research Program, ACRP Report 11, Project 02-06, *Guidebook on Preparing Airport Greenhouse Gas Emissions Inventories*. 2009. http://onlinepubs.trb.org/onlinepubs/acrp/acrp_rpt_011.pdf.
22 Boston Logan International Airport. 2017. Massachusetts Department of Environmental Protection (MassDEP) greenhouse gas (GHG) Emissions Reporting Program.
23 Starting with the 2016 reporting year MassDEP combined GHG Reporting with its Source Registration reporting program.
24 U.S. Environmental Protection Agency (EPA) Greenhouse Gas Summary Report for Boston Logan International Airport for calendar year 2017.

- **Category 2: Tenant Owned** – This category comprises sources owned and controlled by airlines and Airport tenants and includes aircraft (on-ground taxi/idle and within the LTO up to 3,000 feet), GSE/APU, electrical consumption, and tenant employee vehicles.
- **Category 3: Public/Private Owned** – This category comprises GHG emissions associated with passenger ground access vehicles. These include private automobiles, taxis, limousines, buses, and shuttle vans operating on the off-Airport roadway network.

Consistent with ACRP guidelines, the operational boundaries of the GHG emissions are also delineated, reflecting the scope of the emission source (**Table 7-12**) and include:

- **Scope 1/Direct** – GHG emissions from sources that are owned and controlled by the reporting entity (in this case, Massport) such as stationary sources and Airport-owned fleet motor vehicles.
- **Scope 2/Indirect** – GHG emissions associated with the generation of electricity consumed but generated off-site at public utilities.
- **Scope 3/Indirect and Optional** – GHG emissions that are associated with the activities of the reporting entity (in this case, Massport), but are associated with sources that are owned and controlled by others. These include aircraft-related emissions, emissions from Airport tenant activities, as well as ground transportation to and from the Airport.

It is also important to note that the GHG emissions inventory computed for this *2017 ESPR* is consistent with the data provided by Massport for the MassDEP and EPA GHG inventories for Logan Airport. However, the *2017 ESPR* emissions inventory presented to MEPA is more comprehensive, as it covers all three scopes of GHG emissions including those from tenants and the public.[25] By comparison, the EPA GHG Reporting Program covers only stationary sources (Category 1 and Scope 1).

Table 7-13 presents the 2017 GHG emissions inventory, reported in CO_2 equivalent values.[26] As shown, Massport-controlled emissions represent only about 12 percent of total GHG emissions at the Airport. By comparison, aircraft, GSE, and other tenant-based emissions represent about 71 percent, purchased electricity (which includes both Massport and tenant emissions) represents about 7 percent, and passenger ground access vehicle emissions represent about 11 percent of total GHG emissions. Aircraft represent the largest source of emissions followed by motor vehicles and electricity generation, as shown in **Figure 7-12**.

Overall, total GHG emissions in 2017 increased by about 8 percent from 2016 levels. The increase from 2016 to 2017 is largely due to the increase in aircraft LTOs, and on-Airport VMTs. Total Logan Airport GHG emissions remained less than 1 percent of statewide emissions as shown in **Figure 7-13**, and less than 10 percent of citywide emissions as shown in **Figure 7-14**. Massport plans to continue to annually update this GHG Emissions Inventory for Logan Airport.

25 Aircraft cruise mode emissions above the 3,000-foot landing and takeoff cycle (LTO) were not included.

26 CO_2 equivalent values are based upon the Global Warming Potential values of 1 for CO_2, 28 for CH_4, and 265 for N_2O (based on a 100-year period) as presented in the Intergovernmental Panel on Climate Change (IPCC) Fifth Assessment Report (2014).

Table 7-12 Ownership Categorization and Emissions Category/Scope

Owning/Controlling Entity Categories	Source	Category/Scope
Massport Owned and/or Controlled	Massport Fleet Vehicle	Category 1/Scope 1
	On-Airport Ground Transportation	Category 1/Scope 1
	Off-Airport Employee Vehicle Trips	Category 1/Scope 3
	On-Airport Parking Lots	Category 1/Scope 1
	Stationary Sources (includes generators, boilers, etc.)	Category 1/Scope 1
	Fire Training	Category 1/Scope 1
	Electrical Consumption	Category 1/Scope 2
Tenant Owned and/or Controlled (includes airlines, government, concessionaires, aircraft operators, fixed-based operators, etc.)	Aircraft (on-ground, within the LTO up to 3,000 feet)	Category 2/Scope 3
	Auxiliary Power Units	Category 2/Scope 3
	Ground Service Equipment	Category 2/Scope 3
	Off-airport Employee Vehicle Trips	Category 2/Scope 3
	Electrical Consumption	Category 2/Scope 2
Public Owned and Controlled	Off-Airport Vehicle Trips (includes private automobiles, taxis, limousines, buses, shuttle vans, etc., operating on the off-airport roadway network)	Category 3/Scope 3

Source: Transportation Research Board, ACRP Report 11, Guidebook on Preparing Airport Greenhouse Gas Emissions Inventories, 2009, http://onlinepubs.trb.org/onlinepubs/acrp/acrp_rpt_011.pdf, and KBE.

Notes: LTO - landing and takeoff cycle.
Follows ACRP guidance.

Table 7-13 Estimated Greenhouse Gas Emissions (GHG) Inventory (in MMT of CO_2eq) at Logan Airport, 2017[1]

Source	Category	Scope	CO_2	N_2O	CH_4	Totals
Massport-Controlled Emissions						
Ground Service Equipment[2]	1	1	0.01	<0.01	<0.01	0.01
Massport Shuttle Bus	1	1	<0.01	<0.01	<0.01	<0.01
Massport Express Bus	1	1	0.01	<0.01	<0.01	0.01
On-Airport Roadways[3]	1	1	0.03	<0.01	<0.01	0.03
Off-Airport Roadways (Employees)[4]	1	3	<0.01	<0.01	<0.01	<0.01
Parking Lots	1	1	<0.01	<0.01	<0.01	<0.01
Stationary Sources[5]	1	1	0.03	<0.01	<0.01	0.03
Total Massport Emissions (12.1%)			**0.09**	**<0.01**	**<0.01**	**0.09**
Tenant Emissions						
Aircraft – Ground[6]	2	3	0.20	<0.01	<0.01	0.20
Aircraft – Ground to 3,000 feet[7]	2	3	0.24	<0.01	<0.01	0.24
Aircraft Engine Startup	2	3	<0.01	<0.01	-[11]	<0.01
Ground Service Equipment	2	3	0.01	<0.01	<0.01	0.01
Auxiliary Power Units	2	3	0.01	<0.01	-[11]	0.01
Off-Airport Roadways (Employees)[4]	2	3	0.03	<0.01	<0.01	0.03
Total Tenant Emissions (70.6%)			**0.49**	**<0.01**	**<0.01**	**0.50**
Purchased Electricity Emissions[8]						
Massport	1	2	<0.01	<0.01	<0.01	<0.01
Tenant/Common Area	2 and 3	2	0.04	<0.01	<0.01	0.04
Total Purchased Electricity Emissions (6.9%)			**0.05**	**<0.01**	**<0.01**	**0.05**
Passenger Vehicle Emissions						
Off-Airport Roadways[4]	3	3	0.07	<0.01	<0.01	0.07
Total Passenger Vehicle Emissions (10.5%)			**0.07**	**<0.01**	**<0.01**	**0.07**
Total Logan Airport Emissions[9]			**0.70**	**<0.01**	**<0.01**	**0.71**
Percent of Statewide Totals[10]			<1.0%	<1.0%	<1.0%	<1.0%

Source: Massport and KBE, 2019.

Notes: CO – carbon monoxide; NO_X – oxides of nitrogen; PM – particulate matter; VOC – volatile organic compound.

1 MMT - million metric tons of CO_2 equivalents (1 MMT = 1.1M Short Tons). CO_2 equivalents (CO_2eq) are bases for reporting the three primary GHGs (e.g., CO_2, N_2O, and CH_4) in common units. Quantities are reported as "rounded" and truncated values for ease of addition.

2 Ground service equipment include the Logan Airport fleet. Emissions were calculated based on fuel usage.

3 On-airport roadways based on on-site vehicle miles traveled (VMT) and include all vehicles.

4 Off-site roadways based on off-site Airport-related VMT and an average round trip distance of 60.5 miles (2016 Passenger Ground Access Survey).

5 Other sources include Central Heating and Cooling Plant, emergency generators, snow melters, and live fire training facility.

6 Aircraft – Ground emissions include taxi-in, taxi-out and ground-based delay emissions based on AEDT fuel usages.

7 Aircraft – Ground to 3,000 feet include takeoff, climb out, and approach emissions up to a height of 3,000 feet based on AEDT fuel usages.

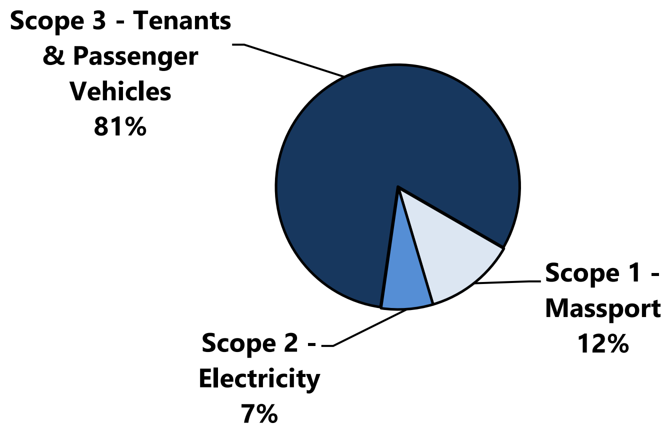
8 Emissions from electrical consumption occurs off-airport at power generating plants.

9 Total Emissions = Airport + Tenant + Public.

10 Percentage based on relative amount of total emissions to statewide total from World Resources Institute (cait.wri.org).

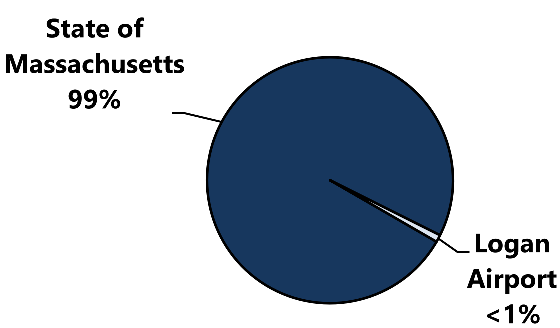
11 The EPA published that: "…methane is no longer considered to be an emission from aircraft gas turbine engines burning Jet A at higher power settings and is, in fact, consumed in net at these higher powers." [Reference: EPA, Recommended Best Practice for Quantifying Speciated Organic Gas Emissions from Aircraft Equipped with Turbofan, Turbojet, and Turboprop Engines, May 27, 2009 [EPA-420-R-09-901], [https://nepis.epa.gov/Exe/ZyPDF.cgi/P1003YX3.PDF?Dockey=P1003YX3.PDF].

Figure 7-12 Sources of GHG Emissions by Scope, 2017



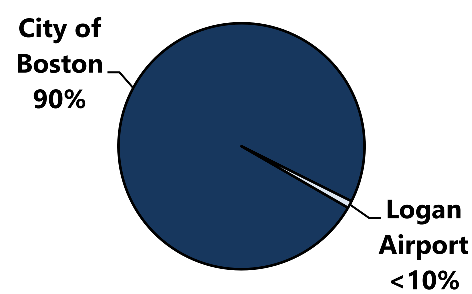
Source: Massport and KBE, 2019.
Notes: Scope 1 emissions are from sources that are owned or controlled by Massport (i.e., ground support vehicles, Massport shuttles, on-airport traffic, and stationary sources), Scope 2 emissions are from electrical consumption (both Massport and tenant), which are generated off-Airport at power generating plants, and Scope 3 emissions are from aircraft, ground service equipment (GSE) including auxiliary power units, and ground transportation to and from the Airport.

Figure 7-13 Logan Airport GHG Emissions Compared to Statewide Emissions



Source: World Resources Institute, Massport, and KBE, 2019.

Figure 7-14 Logan Airport GHG Emissions Compared to the City of Boston Emissions



Source: City of Boston, 2019 (https://www.boston.gov/departments/environment/bostons-carbon-emissions).

Table 7-14 provides GHG data for Logan Airport from 2007 through 2017, by source and by comparison to statewide totals.

Table 7-14 Comparison of Estimated Total Greenhouse Gas (GHG) Emissions (MMT of CO_2eq) at Logan Airport – 2007 through 2017

Source	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Direct Emissions[2]											
Aircraft[3]	0.22	0.21	0.19	0.18	0.19	0.19	0.19	0.20	0.21	0.19	0.21
GSE/APUs	0.08	0.08	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.01	0.03
Motor vehicles[4]	0.03	0.03	0.03	0.03	0.04	0.03	0.05	0.05	0.05	0.05	0.05
Other sources[5]	0.04	0.03	0.03	0.03	0.03	0.02	0.03	0.03	0.03	0.03	0.03
Total Direct Emissions	0.37	0.35	0.27	0.27	0.28	0.26	0.29	0.29	0.32	0.29	0.32
Indirect Emissions[6]											
Aircraft[7]	0.18	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.18	0.22	0.24
Motor vehicles[8]	0.05	0.05	0.05	0.05	0.06	0.05	0.08	0.07	0.08	0.09	0.10
Electrical consumption[9]	0.09	0.08	0.07	0.07	0.08	0.08	0.06	0.06	0.06	0.05	0.05
Total Indirect Emissions	0.32	0.30	0.29	0.29	0.30	0.30	0.31	0.30	0.32	0.36	0.39
Total Emissions[10]	0.69	0.65	0.56	0.56	0.58	0.57	0.60	0.60	0.63	0.65	0.71
Percent of State Totals[11]	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1

Sources: Massport and KBE, 2019.

Notes: Totals may not add exactly due to rounding.

CO – carbon monoxide; NO_X – oxides of nitrogen; PM – particulate matter; VOC – volatile organic compound.

1 MMT – million metric tons of CO_2 equivalents (1 MMT = 1.1M Short Tons). CO_2 equivalents (CO_2eq) are bases for reporting the three primary GHGs (e.g., CO_2, N_2O and CH_4) in common units. Quantities are reported as "rounded" and truncated values for ease of addition.

2 Direct emissions are those that occur in areas located within the Airport's geographic boundaries.

3 Direct aircraft emissions-based engine start-up, taxi-in, taxi-out and ground-based delay emissions.

4 Direct motor vehicle emissions based on on-site vehicle miles traveled (VMT).

5 Other sources include Central Heating and Cooling Plant, emergency generators, snow melters and live fire training facility.

6 Indirect emissions are those that occur off the Airport site.

7 Indirect aircraft emissions are based on takeoff, climb-out and landing emissions which occur up to an altitude of 3,000 ft., the limits of the landing and takeoff (LTO) cycle.

8 Indirect motor vehicle emissions based on off-site Airport-related VMT and an average round trip distance of approximately 60 miles.

9 Electrical consumption emissions occur off-airport at power generating plants.

10 Total Emissions = Direct +Indirect.

11 Percentage based on relative amount of Airport total of direct emissions to statewide total from World Resources Institute (cait.wri.org).

Greenhouse Gas (GHG) Emissions Normalized by Passengers and Building Area

Starting with the *2016 EDR*, Massport has augmented its GHG reporting to include the following metrics:

- GHG emissions (Scopes 1 and 2) per passenger (pounds [lbs] of CO_2 per passenger);
- Building energy use intensity (thousand British thermal units (kBTU) per square foot); and
- Building GHG emissions per square foot (lbs CO_2e per square foot).[27]

As shown in **Table 7-14**, total GHG emissions at Logan Airport have remained relatively constant over the past 10 years while the number of passengers passing through the Airport have increased by over 36 percent. The total square footage of Logan Airport buildings has also increased over this time-period to more efficiently accommodate growing passenger levels. Normalizing the data by number of passengers and square feet shows that Logan Airport's energy efficiency has increased over time.

GHG emissions per passenger have decreased by over 39 percent from 2007 to 2017. **Figure 7-15** includes Scopes 1 and 2 emissions only; these emissions are from sources that are owned or controlled by Massport or are from on-Airport electrical consumption.

Figure 7-16 shows Logan Airport's building energy use intensity, which is a measure of energy consumption per square foot. Logan Airport's energy use intensity has decreased by 23 percent from 2007 to 2017. **Figure 7-17** shows Logan Airport's building GHG emissions per square foot, which has decreased by 44 percent from 2007 to 2017. Building energy is provided from three sources: natural gas, fuel oil, and electricity. **Figures 7-18** and **7-19** show building energy by source and building GHG emissions by source.

These figures demonstrate that Logan Airport is operating more efficiently over time, shifting to cleaner fuel sources, and serving more passengers in a larger building footprint with less energy. The following Massport initiatives have contributed to this success:

- Commitment to Sustainable Design Standards and Guidelines;
- Constructing and operating facilities to LEED® standards and other green-rating systems;
- Ongoing energy efficiency projects, such as converting to light-emitting diode (LED) lighting and upgrading to energy-efficient heating, ventilation, and air conditioning (HVAC) equipment; and
- Installation of on-site renewable energy sources, including solar and wind.

27 Only conditioned (heated and cooled), enclosed building areas are included in the building energy use intensity and GHG emission graphs.

Massport is proud to highlight two recent projects that have implemented its initiatives: The Terminal E Modernization Project and Logan Airport Parking Project.

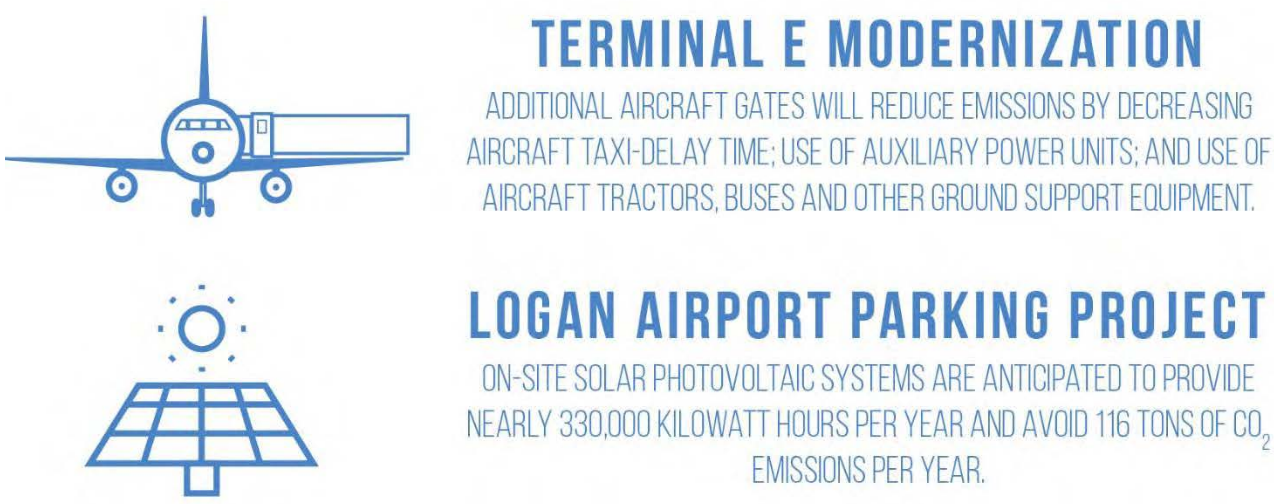
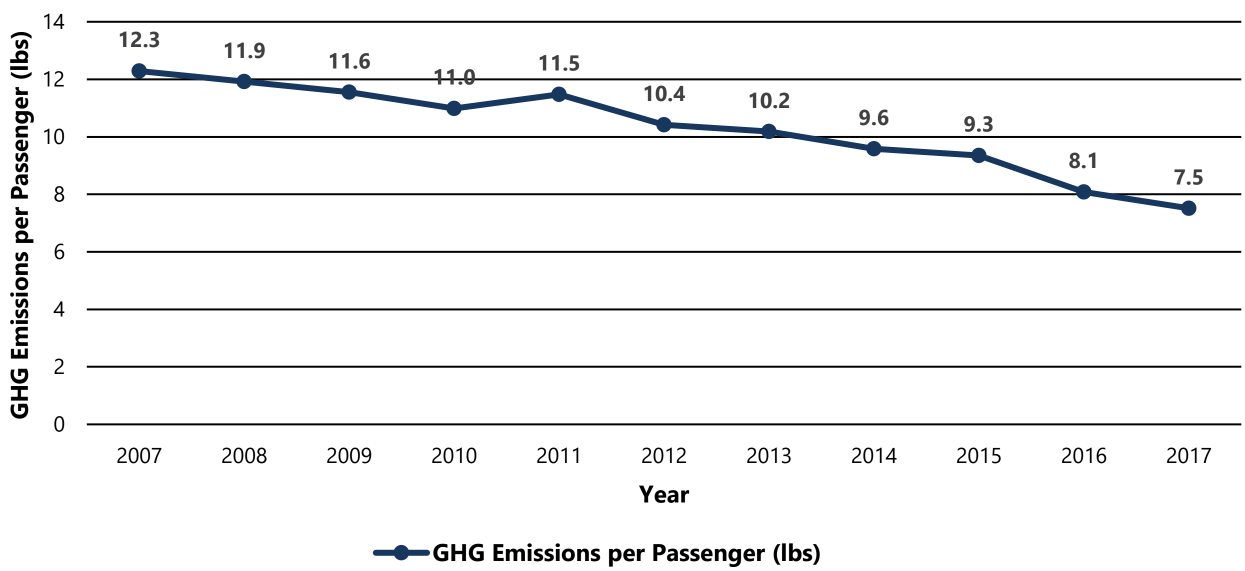
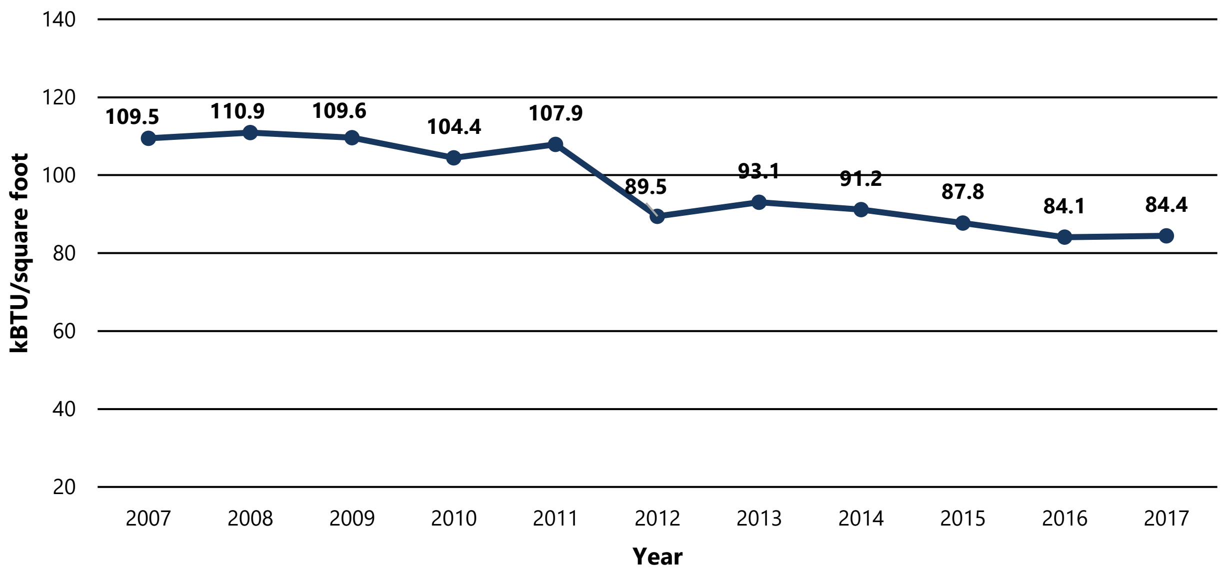


Figure 7-15 GHG Emissions (Scopes 1 and 2) per Passenger (lbs CO_2e), 2007-2017



Source: Massport.
Note: Includes Scopes 1 and 2 data as shown in Table 7-13.

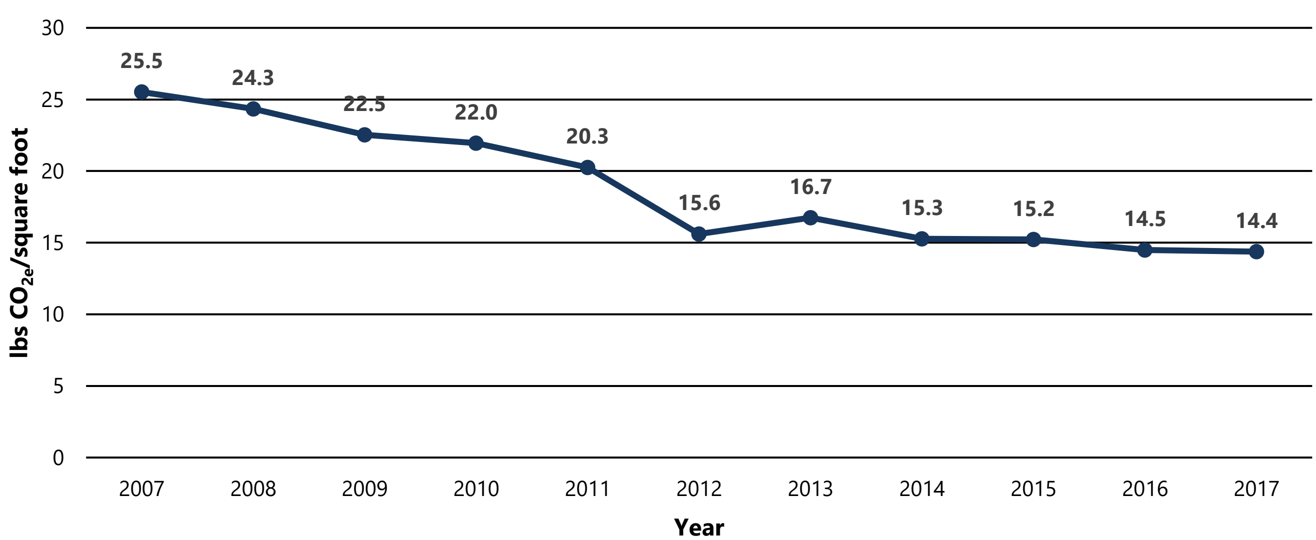
Figure 7-16 Building Energy Use Intensity (kBTU/Square Foot), 2007-2017



Source: Massport.

Notes: kBTU = thousand British thermal units. Electricity (and therefore energy total) has accounted for renewables by taking credit for avoided GHGs for that portion of energy. Therefore, total energy includes some energy that is generated by renewables (with the exception of those that are under Power Purchase Agreements [PPAs]), but the energy total used to calculate GHGs excludes Renewable Energy Credit (REC) purchases and non-PPA on-site renewable generation.

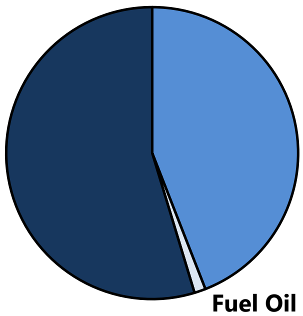
Figure 7-17 Building GHG Emissions (lbs CO_2e) per Square Foot, 2007-2017



Source: Massport.

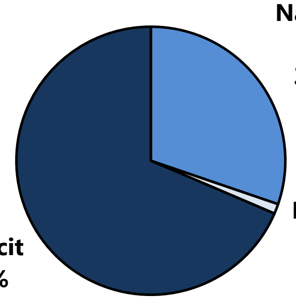
Notes: Electricity (and therefore energy total) has accounted for renewables by taking credit for avoided GHGs for that portion of energy. Therefore, total energy includes some energy that is generated by renewables (with the exception of those that are under Power Purchase Agreements [PPAs]), but the energy total used to calculate GHGs excludes Renewable Energy Credit (REC) purchases and non-PPA on-site renewable generation.

Figure 7-18 Building Energy Sources



Source: Massport.

Figure 7-19 Building Greenhouse Gas Emission Sources



Source: Massport.

Future Planning Horizon Greenhouse Gas (GHG) Emissions

As with the 2017 analysis, the future GHG emission inventory is based on guidance developed by TRB's ACRP to compute GHG emissions.[28] Thus, the projection of future GHG emissions also assigns emissions based on ownership or control (e.g., Massport, airlines and other Airport tenants, and the general public). The vast majority of emission sources at Logan Airport are owned or controlled by the airlines, Airport tenants, (through emissions from aircraft and GSE), and the general public (through emissions from motor vehicles). The Future Planning Horizon Massport-related emissions are expected to represent about 10 percent of total GHG emissions at the Airport. Tenant-based emissions are anticipated to represent about 71 percent; electrical consumption from Massport, common areas, and tenants are anticipated to represent about 7 percent; and passenger vehicle emissions are anticipated to represent about 12 percent of total GHG emissions. **Table 7-15** presents the predicted Future Planning Horizon GHG emissions inventory reported in CO_2 equivalent values.

The expected increase in operations is partially offset by greater motor vehicle and GSE fuel efficiencies (associated with advancements in equipment technology on a nationwide basis and regulatory requirements). Additionally, initiatives are underway within the U.S. and internationally to reduce aviation's contribution to global GHG emissions. Such initiatives include new aircraft technologies to reduce emissions and improve fuel efficiency, renewable alternative fuels with lower carbon footprints, more efficient air traffic management, market-based measures, and environmental regulations including an aircraft CO_2 standard.

28 Transportation Research Board, Airport Cooperative Research Program, ACRP Report 11, Project 02-06, *Guidebook on Preparing Airport Greenhouse Gas Emissions Inventories*. 2009. http://onlinepubs.trb.org/onlinepubs/acrp/acrp_rpt_011.pdf.

Table 7-15 Estimated Greenhouse Gas (GHG) Emissions Inventory (in MMT of CO2eq) at Logan Airport, Future Planning Horizon[1]

Source	Category	Scope	CO_2	N_2O	CH_4	Totals
Massport-Controlled Emissions						
Ground Service Equipment[2]	1	1	0.01	<0.01	<0.01	0.01
Massport Shuttle Bus	1	1	<0.01	<0.01	<0.01	<0.01
Massport Express Bus	1	1	0.01	<0.01	<0.01	0.01
On-Airport Roadways[3]	1	1	0.03	<0.01	<0.01	0.03
Off-Airport Roadways (Employees)[4]	1	3	<0.01	<0.01	<0.01	<0.01
Parking Lots	1	1	0.01	<0.01	<0.01	0.01
Stationary Sources[5]	1	1	0.03	<0.01	<0.01	0.03
Total Massport Emissions (10.4%)			**0.09**	**<0.01**	**<0.01**	**0.09**
Tenant Emissions						
Aircraft – Ground[6]	2	3	0.24	<0.01	-[10]	0.24
Aircraft – Ground to 3000 feet[7]	2	3	0.33	<0.01	<0.01	0.33
Aircraft Engine Startup	2	3	0.01	<0.01	-[11]	0.01
Ground Service Equipment	2	3	<0.01	<0.01	<0.01	<0.01
Auxiliary Power Units	2	3	0.01	<0.01	-[11]	0.01
Off-Airport Roadways (Employees)[4]	2	3	0.03	<0.01	<0.01	0.03
Total Tenant Emissions (70.6%)			**0.61**	**0.01**	**<0.01**	**0.61**
Purchased Electricity Emissions[8]						
Massport	1	2	0.01	<0.01	<0.01	0.01
Tenant/Common Area	2 and 3	2	0.05	<0.01	<0.01	0.05
Total Purchased Electricity Emissions (6.9%)			**0.06**	**<0.01**	**<0.01**	**0.06**
Passenger Vehicle Emissions						
Off-Airport Roadways[4]	3	3	0.11	<0.01	<0.01	0.11
Total Passenger Vehicle Emissions (12.1%)			**0.11**	**<0.01**	**<0.01**	**0.11**
Total Logan Airport Emissions[9]			**0.86**	**0.01**	**<0.01**	**0.87**

Source: Massport and KBE, 2019.

Notes: CO – carbon monoxide; NO_X – oxides of nitrogen; PM – particulate matter; VOC – volatile organic compound.

1 MMT - million metric tons of CO_2 equivalents (1 MMT = 1.1M Short Tons). CO_2 equivalents (CO_2eq) are bases for reporting the three primary GHGs (e.g., CO_2, N_2O, and CH_4) in common units. Quantities are reported as "rounded" and truncated values for ease of addition.

2 Ground service equipment (GSE) include the Logan Airport fleet. Emissions were calculated based on fuel usage.

3 On-airport roadways based on on-site vehicle miles traveled (VMT) and includes all vehicles.

4 Off-site roadways based on off-site Airport-related VMT and an average round trip distance of 60.5 miles (2016 Passenger Ground Access Survey).

5 Other sources include Central Heating and Cooling Plant, emergency generators, snow melters, space heaters, and live fire training facility.

6 Aircraft – Ground emissions include taxi-in, taxi-out and ground-based delay emissions based on AEDT fuel usages.

7 Aircraft – Ground to 3,000 feet include takeoff, climb out, and approach emissions up to a height of 3,000 feet based on AEDT fuel usages.

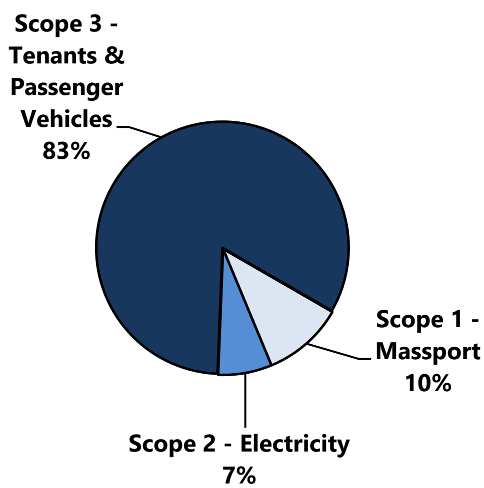
8 Emissions from electrical consumption occurs off-airport at power generating plants.

9 Total Emissions = Airport + Tenant + Public.

10 The EPA published that: "…methane is no longer considered to be an emission from aircraft gas turbine engines burning Jet A at higher power settings and is, in fact, consumed in net at these higher powers." [Reference: EPA, Recommended Best Practice for Quantifying Speciated Organic Gas Emissions from Aircraft Equipped with Turbofan, Turbojet, and Turboprop Engines, May 27, 2009 [EPA-420-R-09-901], https://nepis.epa.gov/Exe/ZyPDF.cgi/P1003YX3.PDF?Dockey=P1003YX3.PDF.

As shown in **Figure 7-20**, in the Future Planning Horizon tenants and passenger vehicles (Scope 3) represent the largest source of GHG emissions at 83 percent, followed by Massport (Scope 1) at 10 percent, and electrical consumption (Scope 2) at 7 percent.

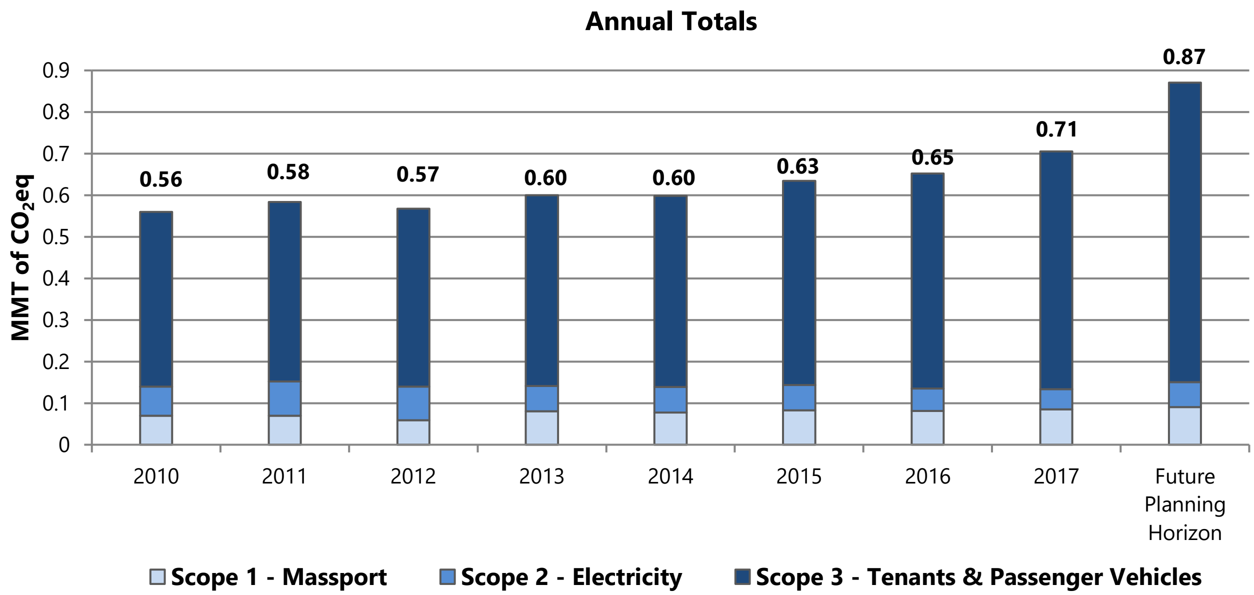
Figure 7-20 Sources of GHG Emissions, Future Planning Horizon



Source: Massport and KBE, 2019.
Note: Scope 1 emissions are from sources that are owned or controlled by Massport, Scope 2 emissions are from electrical consumption, which are generated off-Airport at power generating plants, and Scope 3 emissions are from airport tenants and ground transportation to and from the airport.

As shown in **Figure 7-21**, total future GHG emissions are estimated to be approximately 23 percent higher than 2017 levels, attributable to the forecasted approximate 21-percent increase in aircraft operations and 31-percent increase in passenger traffic, each resulting in an increase in fuel usage and VMT. The increase in total GHG emissions is primarily attributable to the increase in Scope 3 emissions (tenants and passenger vehicles). Scope 1 emissions (Massport) are predicted to increase slightly due to an increase in the number of passengers using facilities at Logan Airport. Scope 2 (electricity) is predicted to also increase slightly due to the projected Terminals B, C, and E area expansion.

Figure 7-21 Emissions of GHG at Logan Airport 2010-2017, Future Planning Horizon



Source: Massport and KBE, 2019.
Note: Scope 1 emissions are from sources that are owned or controlled by Massport, Scope 2 emissions are from electrical consumption, which are generated off-Airport at power generating plants, and Scope 3 emissions are from airport tenants and ground transportation to and from the Airport.

Air Quality Emissions Reduction

As part of implementing and advancing its ongoing air quality management strategy for Logan Airport, Massport has established a number of goals and objectives to address air emissions from Airport operations, including the minimization of Airport-related emissions through the reduction of GSE and Massport vehicle fleet emissions. This section presents an update on these initiatives at Logan Airport.

Alternative Fuel Vehicles (AFV) Program

A component of Massport's Air Quality Management Program is the AFV Program. The AFV Program is designed to replace Massport's conventionally-fueled fleet with alternatively fueled or powered vehicles, when feasible, to help reduce emissions associated with Logan Airport operations. Massport now operates 92 vehicles powered by CNG, propane, E85 flex fuel, diesel/electric hybrid, and gasoline/electric hybrid. Massport also established a vehicle procurement policy in 2006 that requires consideration of AFVs when purchases are made. For example, beginning in 2013, as part of the Southwest Service Area (SWSA) redevelopment, the existing fleet of diesel rental car shuttle buses was replaced by CNG or clean diesel-electric hybrid buses. In 2017, two CNG Honda Civics were retired, and the remaining seven are planned for retirement in 2019 for replacement with even lower emission vehicles. The remaining CNG pick-up trucks and vans were retired in 2018. **Table 7-16** shows the number of Massport AFVs by vehicle type in 2017. As discussed in Chapter 1, *Introduction/Executive Summary*, several projects and programs support AFVs at Logan Airport including:

- The replacement of 94 diesel rental car buses and older CNG buses with a fleet of 54 alternative fuel (diesel-electric hybrids and newer generation CNG) buses, serve the new Rental Car Center (RCC), Massport terminals, and other airport shuttle routes.
- Operation for almost two decades of one of the largest privately operated, publicly accessible, CNG stations in New England. In 2017, the station dispensed approximately 25,200 gasoline-equivalent gallons per month for Massport vehicles.
- The use of battery powered tugs and belt loaders for the Delta Air Lines ground service fleet at Terminal A.
- A total of 115 eGSE in service at Logan Airport. As part of its long-range emission reduction strategy, Massport is working with the airlines to replace 25 percent of all commercially-available GSE with electric alternatives by 2022, and 100 percent by the end of 2027
- Installation of 13 EV charging stations to accommodate a total of 26 vehicles in the Central Garage and Terminal B parking areas. There are also two charging stations at the Framingham Logan Express Garage. Massport has committed to increasing the availability of EV charging stations so that 150 percent of this demand is available at all facilities, at all times. There are 64 charging stations installed at Logan Airport and its Logan Express sites, with 58 additional stations planned to be installed by 2020.
- Continued operation of Massport's "Clean-Air-Cab" incentive program for AFVs, which allows hybrid or alternative fuel taxis to go to the head of the taxi line to serve passengers.

In addition, Logan Airport's Green Bus Depot is designed to maintain the expanded CNG-fueled and clean diesel-electric hybrid shuttle bus fleet. Since 2007, Massport also offers preferred parking for customers driving hybrid and AFVs.

Table 7-16 Massport's Alternative Fuel Vehicle Fleet (AFV) Inventory at Logan Airport

Fuel Type	Vehicle	2017
Diesel/Electric Hybrid	Shuttle Bus[1]	32
Compressed Natural Gas (CNG)	Van	3
	Pick-Up Truck	3
	Honda Civic	7
	CNG NABI Bus[2]	22
Gasoline/Electric Hybrid	Ford Escape	2
Propane	Non-Road Vehicles (Forklifts)	1
E85 Flex Fuel	Pick-Up Truck	18
	Van	2
	Ford Escape	2
	Total	**92**

Source: Massport.
1 The 32 diesel/electric hybrid shuttle buses, added to the fleet in 2013, replaced the diesel rental car buses.
2 The CNG NABI buses replaced the 26 aging CNG shuttle buses.

Air Quality Management Goals

Massport's air quality management strategy for Logan Airport focuses on decreasing emissions from Airport-related sources, in addition to furthering innovative means to achieve emissions reductions Airport-wide. Massport's air quality improvement goals, the measures proposed to accomplish them, and some of the 2017 milestones are listed in **Table 7-17**. Massport continues to comply with the Logan Airport Parking Freeze,[29] in accordance with 10 Code of Massachusetts Regulations 7.30 and 40 Code of Federal Regulations 52.1135. Chapter 5, *Ground Access to and from Logan Airport*, provides detailed discussion of Massport's compliance with the Parking Freeze regulation, and the counterproductive effect of constrained parking at Logan Airport on VMT and associated emissions.

Table 7-17 Air Quality Management Strategy Status

Air Quality Emissions Reduction Goals	Plan Elements	2017 Status
Reduce emissions from Massport fleet vehicles	Convert Massport fleet vehicles to electricity or compressed natural gas (CNG) by retrofitting or procurement.	In 2016, one additional CNG NABI bus was acquired, totaling to a fleet of 54 alternative fuel vehicle (AFV)/alternative power vehicle (APV) buses. No additional CNG NABI buses were acquired in 2017. Massport is facilitating the replacement of gas- and diesel-powered ground service equipment (GSE) with all-electric versions. All GSE at the Airport will be replaced by electric equivalents by the end of 2027, as commercially available. The U.S. Environmental Protection Agency (EPA) awarded a $541,817 grant in 2018 to Massport to replace gas- and diesel-powered GSE at Logan Airport in a collaborative effort to reduce emissions and improve air quality. Massport contributed a $622,221 match. This grant will allow Massport to replace 25 pieces of diesel-powered GSE with all-electric versions. This grant will be used in conjunction with a Federal Aviation Administration (FAA) grant Massport received in the fall of 2018 to install electric GSE (eGSE) charging stations for the Terminal B Optimization Project.
Encourage use of alternative fuel and alternative power vehicles by private fleet and airside service vehicle owners	Provide infrastructure to support alternative fuels including CNG and electricity.	Massport continues to operate one of New England's largest retail CNG stations, which is open to the public. In calendar year 2017, the CNG station pumped approximately 25,234-gallon equivalents per month for all Massport fleet vehicles (non-Massport vehicles were also using CNG). Massport plans to support the current and future standard systems for plug-in electric vehicles (EVs). For example, the Rental Car Center (RCC) in the Southwest Service Area (SWSA) includes the infrastructure necessary to accommodate future plug-in stations for EVs. Currently, there are 64 charging stations installed at Logan Airport and its Logan Express sites, with 58 additional stations planned to be installed by 2020.

29 310 Code of Massachusetts Regulations 7.30 and 40 Code of Federal Regulations 52.1120.

Table 7-17 Air Quality Management Strategy Status (Continued)

Air Quality Emissions Reduction Goals	**Plan Elements**	**2017 Status**
Encourage use of alternative fuel and alternative power vehicles by private fleet and airside service vehicle owners	Work with ground access fleet and airside service-vehicle owners to encourage conversion.	Massport encourages conversion to AFVs/APVs by others through such policies as 50-percent discounts in AFV/APV ground access fees to limousines, vans, and buses; limited “front-of-line” taxi pool privileges to hybrid and AFVs/APVs; and preferred parking for hybrid and AFVs/APVs at Logan Airport parking facilities.
Minimize emissions from motor vehicles	Implement a program to increase high occupancy vehicle (HOV) ridership by air passengers.	As described in detail in Chapter 5, *Ground Access to and from Logan Airport,* there are a number of HOV services serving Logan Airport that are aimed at air passengers, including the Massachusetts Bay Transportation Authority (MBTA) Blue Line and Silver Line, Logan Express, and water transportation. Massport promotes the use of these services by employees, primarily through various pricing incentives. Massport has developed a robust strategy to increase HOV, including improving Back Bay Logan Express service, planned the start of a new urban Logan Express from North Station, enhancing services and amenities at existing suburban Logan Express sites, increasing parking capacity at existing sites, and identifying new suburban Logan Express locations. More information about this strategy can be found in Chapter 5, *Ground Access to and from Logan Airport*. Massport provides free, clean-fuel shuttle bus service for passengers and employees between the MBTA Blue Line Airport Station, all terminals, the Rental Car Center, and the Logan Airport water transportation dock along Harborside Drive.
	Expand the Logan Transportation Management Association (TMA) for Airport employees.	Massport continues to provide commuting information to all Airport employees including Sunrise and Logan Express Shuttles with reductions in employee parking. Logan Express extended service now provides nearly 24-hour service at several Logan Express locations, with significant discounts provided to Airport-wide and Massport employees.
	Encourage employees to use bicycling as a mode of commuting.	Massport includes bike racks at all new facilities and at appropriate existing facilities to promote employees biking to work. Bicycle racks are currently provided at the RCC, Terminal A, Terminal E, Logan Office Center, MBTA’s Airport Station, Economy Parking Garage, Signature general aviation facility, and the Green Bus Depot (Bus Maintenance Facility).
Minimize emissions from Construction Equipment	Incorporate Clean Air Construction Initiative (CACI) into major earthwork construction projects.	For all large construction projects, heavy construction equipment is required to be equipped with diesel particulate filters or diesel oxidation catalysts in accordance with CACI.

Table 7-17 Air Quality Management Strategy Status (Continued)

Air Quality Emissions Reduction Goals	Plan Elements	2017 Status
Reduce emissions from fuel vapor loss	Provide state-of-the-art fuel storage and distribution equipment.	The Fuel Storage and Distribution System is in operation.
	Implement Tank Management Program.	Refer to Chapter 8, *Environmental Compliance and Management/ Water Quality,* which provides details regarding tank management focuses on proper maintenance.
Reduce emissions from stationary sources	Employ Reasonable Available Control Technologies (RACT) for NO_x at Central Heating and Cooling Plant.	RACT policies have been implemented.
	Use alternative fuels in snow melters.	Massport is required to use Ultra Low Sulfur Diesel fuel in all Massport snow melting equipment. Massport installed two new stationary snow melters using natural gas in 2016 and two additional snow melters to be operational by November 2019. These installations will reduce the need for Ultra Low Sulfur Diesel fuel fired portable snow melters.
	Incorporate green building technologies and energy use reduction strategies.	Logan Airport has five U.S. Green Building Council (USGBC)'s Leadership in Energy and Environmental Design (LEED®) certified facilities: Terminal A (the first LEED® certified terminal in the world), the Signature Flight Support General Aviation (GA) Facility, the Green Bus Deport (LEED® Silver certified), the RCC (LEED® Gold), and a recently renovated portion of Terminal E (LEED® Gold). An overview of sustainability initiatives is presented in Chapter 1, *Introduction/Executive Summary*.
	Install diesel particulate filters on large emergency generators	Massport has voluntarily installed diesel particulate filters on all large (>500 kilowatts) stationary emergency generators beginning in 2011.
Reduce aircraft emissions	Work with FAA to study and implement airfield-improvement concepts and operational changes that may have air quality benefits.	Massport promoted such concepts through the *Logan Airside Improvements Planning Project Environmental Impact Statement*, which recommended physical and operational improvements to Logan Airport including construction of the new Runway 14-32 and Centerfield Taxiway, and taxiway improvements. Runway 14-32 became operational in November 2006 and the Centerfield Taxiway was fully opened in summer of 2009. In addition, in coordination with Massport, the Massachusetts Institute of Technology (MIT) completed a detailed survey of pilots at Logan Airport to better understand the use of single engine taxiing and issued a paper in March 2010, and in January 2011, MIT published a paper on aircraft pushback control strategies to reduce congestion and taxi delay.

Table 7-17 Air Quality Management Strategy Status (Continued)

Air Quality Emissions Reduction Goals	Plan Elements	2017 Status
Reduce aircraft emissions	Use of pre-conditioned air at new and renovated terminals and terminal gates.	The majority of contact gates have pre-conditioned air and/or 400-Hz power. This reduces the need for auxiliary power unit (APUs), and consequently reduces associated emissions. The recent improvements of Terminal B included the installation of pre-conditioned air at all renovated gates.
Reduce energy intensity and greenhouse gas (GHG) emissions while increasing portion of Logan Airport's energy generated from renewable sources	Reduce energy consumption Increase the portion of Massport's energy being generated from renewable sources Reduce overall GHG emissions associated with energy consumed in Massport operated facilities at Logan Airport Reduce GHG emissions from Massport-operated mobile sources	This goal was identified as part of the Logan Airport Sustainability Management Plan (SMP)[1], which was released in April 2015. In the 2018 Annual Sustainability & Resiliency Report, Massport identified several policies and initiatives its implementing to achieve this goal, including pursuing LEED® accreditation for new projects and upgrading to energy-efficient heating, ventilation, and air conditioning (HVAC) systems. As of FY2017, Massport had achieved a 46 percent reduction in GHG emissions per passenger, exceeding its 2020 target by about 6 percent. Massport also reduced its energy use per passenger by 26 percent and energy use per square foot by 25 percent, reaching its goal of a 25-percent reduction by 2020. Progress on this goal will be reported in future sustainability reports.

1 Progress towards goals identified as part of the Logan Airport Sustainability Management Plan (SMP) will be reported separately, as part of Massport's annual sustainability reporting.

Updates on Other Air Quality Efforts

This section further highlights other Logan Airport-related air quality efforts in 2017.

Massachusetts Department of Public Health Study

In 2004, the Massachusetts Legislature appropriated funds for the Department of Public Health (DPH) to undertake an assessment of potential health impacts of Logan Airport in the East Boston section of the city and any other communities located within a five-mile radius of the Airport, with a focus on noise and air quality. This study was completed in May 2014 and consisted of an epidemiological survey combined with computer modeling of noise levels and air pollution concentrations. Massport has cooperated in this effort by providing funding to complete the study and Airport operational data in support of the study. In the spring of 2011, Massport also gave technical assistance in support of the DPH study by providing geographic information systems (GIS) analysis of the roadway network in and around Logan Airport in a format compatible with FAA's EDMS. Massport is working with DPH and the East Boston Health Center on implementing DPH recommendations related to Massport.

In response to the DPH study recommendations, Massport has:

- Entered into an agreement to provide funding to the East Boston Neighborhood Health Center to help expand the efforts of their Asthma and Chronic Obstructive Pulmonary Disease (COPD) Prevention and Treatment Program in East Boston and launch a program in Winthrop that provides services including screenings for children, distribution of asthma kits, and home visits, among others.
- Entered into an agreement with the Massachusetts League of Community Health Centers for the evaluation and assessment of the Asthma and COPD Prevention and Treatment Program, and engagement of community health centers in the North End, Charlestown, Chelsea, and South Boston. The East Boston Neighborhood Health Center will conduct the same evaluations for the East Boston and Winthrop community programs.
- Entered into an agreement with DPH to expand or establish the Asthma and COPD Prevention and Treatment Program in South Boston, the North End, Chelsea, and Charlestown in collaboration with the Massachusetts General Hospital, South Boston Neighborhood Health Center, and conduct training on the Community Health Worker assessments.

The findings from this study can be viewed from DPH website at: http://www.mass.gov/eohhs/docs/dph/environmental/investigations/logan/logan-airport-health-study-final.pdf.

Single Engine Taxiing

Single engine taxiing is one measure that is being used by air carriers to help reduce fuel use and emissions. As a result, Massport supports the use of single engine taxiing when it can be done safely, voluntarily and at the discretion of the pilot. Massport has conducted three surveys of Logan Airport air carriers (2006, 2009, and 2010) to understand the extent single engine taxiing is used at Logan Airport. In addition, Massport is an active member of the FAA Partnership for Air Transportation Noise and Emissions Reduction (PARTNER) program on reducing noise and emissions. In 2009, Massport offered to facilitate a more detailed survey of pilots at Logan Airport by the Massachusetts Institute of Technology (MIT) to better understand the use of single engine taxiing. MIT completed its survey and issued a paper in March 2010, which was provided in the *2009 EDR*. The MIT survey confirms earlier Massport survey findings that single engine taxiing is an important operational measure used by airlines to conserve fuel and is extensively used at Logan Airport. MIT issued a paper in January 2011 reporting on a control strategy to minimize airport surface congestion, and thus taxiing time, by regulating the rate at which aircraft are pushed back from their gates. Also, in January 2011, Massport sent a memorandum to air carriers in support of single engine taxiing when consistent with safety procedures. The memorandum highlighted best practices for single engine taxiing use based on the MIT survey findings. In May 2017, May 2018, and June 2019, Massport sent additional memoranda to air carriers in support of single/reduced-engine taxiing and the use of idle reverse thrust as strategies. Copies of these memoranda are provided in Appendix L, *Reduced/Single Engine Taxiing at Logan Airport Memoranda.*

MIT and the Center for Air Transportation Systems Research developed a methodology to account for single engine taxi procedures during the taxi-in or -out modes.[30,31,32] Some of the single engine taxi challenges noted in these studies include: (1) excessive thrust and associated issues; (2) maneuverability problems particularly related to tight taxiway turns and weather; (3) problems starting the second engine; and (4) distractions and workload issues. Thus, pilots do not use single engine taxiing during each aircraft operation in practice, and when they do use it, it is not for the entire operation. Pilots use single engine taxiing even less often when taxiing out.

When applying the MIT methodology and available data (such as aircraft pilot surveys) to the most recent set of aircraft operational data for Logan Airport (i.e., 2017), the results show a savings of approximately 1,820,261 gallons of jet fuel and a reduction of approximately 17,910 metric tons of GHG emissions associated with this initiative.

Engagement in Aviation-Related Environmental Issues

Massport maintains memberships and active participation in a number of organizations involved in addressing aviation-related environmental issues, including air quality. These include environmental committees for TRB, the American Association of Airport Executives (AAAE), and the Airports Council International-North America (ACI-NA).

Black Carbon (BC)

Particulate matter at all sizes is comprised of multiple components, one of the more significant being BC. BC particles, also referred to as soot, form as a result of incomplete combustion, particularly at the higher temperatures at which aircraft burn fuel, making BC emissions common from aircraft. BC from aviation activities largely contributes to smaller PM particles (i.e., $PM_{2.5}$ and UFPs). $PM_{2.5}$ is classified as a criteria air pollutant by EPA and regulated under NAAQS.

BC is known to have negative impacts on both human health and the environment. According to EPA, BC is associated with respiratory distress, cardiovascular disease, cancer, and birth defects. A recent study using air quality monitors near an airport has shown that airports can contribute to 24 to 28 percent of total BC within 4 km.[33] However, modeling studies, commonly used to ascertain the extent of impacts on human health and the environment, have shown the level of contribution by an airport to be less, only on the order of 2 to 5 percent. Researchers are working on understanding the reasons for this discrepancy. It may be an indication that emissions estimates from airports need improvement.[34]

30 Massachusetts Institute of Technology. 2010. *A Survey of Airline Pilots Regarding Fuel Conservation Procedures for Taxi Operations*.
31 Massachusetts Institute of Technology. 2008. *Opportunities for Reducing Surface Emissions through Airport Surface Movement Optimization*.
32 Center for Air Transportation Systems Research. *Analysis of Emissions Inventory for Single Engine Taxi-out Operations*. 2009.
33 Dodson R. E.; Houseman E. A.; Morin B.; Levy J. I. 2009. *An analysis of continuous black carbon concentrations in proximity to an airport and major roadways.* Atmos. Environ, 43243764–3773.
34 Arunachalam S.; Valencia A.; Yang D.; Davis N, Baek B.H.; Dodson R.E.; Houseman A.E.; Levy J.I. 2011. *Comparing Monitoring-Based and Modeling-Based Approaches for Evaluating Black Carbon Contributions from a US Airport.* Air Pol. Mod, 619-623

To fully understand the extent of impacts from airport-related BC emissions much more research is needed. It is important for research to focus on improving emissions estimates of BC from airports and improved modeling studies. FAA conducts research through the ASCENT program on BC.

Statewide, National, and International Initiatives

Advancements on the national and international levels to decrease Airport-related air emissions have continued to focus primarily on three initiatives: the advanced quantification of PM and hazardous air pollutants (HAPs) emissions from aircraft engines; the continued phasing-in of AFV; and the implementation of GHG emissions reduction strategies. These initiatives are briefly described below.

- **PM and Hazardous Air Pollutant Research** – Conducted by the ICAO, FAA, EPA, and others, research continues to better characterize PM and HAPs emissions (including lead) from aircraft engines. Similarly, air quality monitoring efforts at other airports were also conducted at various locations to advance what are known about ambient levels of these air pollutants in the vicinities of airports. Massport continues to closely track these issues through its involvement in aviation industry organizations such as ACI-NA and AAAE.

- **AFV Conversions** – Airlines and other GSE users are continually replacing their older fossil-fueled vehicles and equipment with more fuel-efficient, low- and non-emitting (e.g., electric) technologies. Airport-fleet vehicles are also being converted to alternative fuels (e.g., electric, propane). In response, GSE and automobile manufacturers are offering a wider selection of AFVs, many of which are designed specifically for airport use. Massport continues to support the conversion of fossil-fueled vehicles and equipment to alternative, electric, or lower-emitting fuels. Massport is replacing all commercially-available diesel-powered GSE to all-electric versions by the end of 2027. The EPA awarded a $541,817 grant in 2018 to Massport to replace gas- and diesel-powered GSE at Logan Airport in a collaborative effort to reduce diesel emissions and improve air quality. Massport contributed a $622,221 match. This grant will allow Massport to assist American Airlines with the replacement of 25 pieces of diesel-powered GSE with all-electric versions. This grant will be used in conjunction with an FAA grant Massport received in the fall of 2018 to install eGSE charging stations for the Terminal B Optimization Project

- **Participation in Massachusetts Climate Protection Plan** – Massport was one of 15 state agencies and authorities that participated in the development of the State's Climate Protection Plan, the Commonwealth's initial step towards reducing GHG emissions. Massport is participating on two of the Plan's teams: Transportation System Planning and Transportation Technologies and Operations, with a focus on GHG emission reductions associated with Airport operations. Current reduction strategies include:
  - Incorporating energy use and GHG emissions as criteria in transportation decisions;
  - Maintaining and updating public transit systems;
  - Expanding programs to promote efficient travel;
  - Seeking opportunities to reduce emissions at Logan Airport;
  - Improving aircraft movement efficiency;
  - Promoting the use of cleaner vehicles and fuels in public transit fleets;
  - Continuing to promote the use of clean diesel equipment on publicly-funded construction projects;
  - Eliminating unnecessary idling of buses; and
  - Advocating for aircraft efficiency at regional and national levels.
- **Sustainable Aviation Fuels** – International Air Transport Association (IATA) approved a resolution for the governments to continue in implementing the Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA). To achieve a carbon-neutral growth, this initiative sets a cap on net CO_2 emissions generated from international aviation at 2020 levels. Airlines are also encouraged to use biofuels, or other sustainable aviation fuels, as a fuel efficiency measure.[35] In May 2019, United Airlines agreed to purchase up to 10 million gallons of cost-competitive, commercial-scale, sustainable aviation biofuel over the next two years. Currently, every United Airlines flight out of Los Angeles International Airport are powered by biofuel. United Airlines has renewed its contract with Boston's World Energy, a biofuel producer, to help achieve its commitment to reducing its GHG emissions by 50 percent by 2050.[36]

35 Biofuels international, IATA resolution urges airlines to switch to sustainable aviation fuels. June 3, 2019. https://biofuels-news.com/display_news/14744/iata_resolution_urges_airlines_to_switch_to_sustainable_aviation_fuels/.

36 Good News Network, As Only US Airline to Use Biofuel on Regular Basis, All United Flights from LA Are Now Powered by Biofuel. June 10, 2019. https://www.goodnewsnetwork.org/united-airlines-flights-from-la-powered-by-biofuel/.

This Page Intentionally Left Blank.

8

Environmental Compliance and Management/ Water Quality

Key Findings
▪ The Massachusetts Port Authority (Massport) promotes appropriate environmental practices through pollution prevention and remediation measures. Massport also works closely with tenants and operations staff at Boston Logan International Airport (Logan Airport or the Airport) in an effort to continuously improve environmental compliance.
▪ In 2017, 100 percent of Massport's stormwater samples were in compliance with National Pollutant Discharge Elimination System (NPDES) permit requirements.
▪ Massport has had its International Organization for Standardization (ISO) 14001 Environmental Management System (EMS) in place since 2006.
▪ Massport annually updates and maintains its Stormwater Pollution Prevention Plan (SWPPP) for Logan Airport.
▪ Massport continues to assess, remediate, and bring to regulatory closure areas of subsurface contamination. The Southwest Service Area Massachusetts Contingency Plan (MCP) Site, Release Tracking Number (RTN) 3-32022, achieved regulatory closure in November 2017.
▪ Eight spills required reporting in 2017, a decrease from the 2016 reportable spills (14 total). The number of spills entering a drainage system also decreased, from five in 2016 to two in 2017.

Introduction

Massport's approach to environmental management and compliance is a key component of its commitment to sustainability and responsible stewardship at Logan Airport (refer to Chapter 1, *Introduction/Executive Summary,* for details). Through monitoring and documentation, Massport assesses environmental performance, continually developing, implementing, evaluating, and improving policies and programs. In October 2000, the Massport Board approved a Massport-wide Environmental Management Policy, which articulates the agency's commitment to protect the environment and to implement sustainable design principles:

> *"Massport is committed to operate all of its facilities in an environmentally sound and responsible manner. Massport will strive to minimize the impact of its operations on the environment through the continuous improvement of its environmental performance and the implementation of pollution prevention measures, both to the extent feasible and practicable in a manner that is consistent with Massport's overall mission and goals."*

Massport's overall environmental compliance and management efforts include:

- Environmental inspections and recommendations to rectify identified issues;
- Compliance with the EMS and ISO 14001;
- Continued publication of the *Sustainable Massport* quarterly newsletter;
- Annual updates of the Logan Airport SWPPP and training for personnel responsible for implementing activities identified in the SWPPP;
- Development of sustainable design standards and guidelines (SDSGs) for architects, engineers, and planners; and
- Development of a Spill Prevention Control and Countermeasure (SPCC) plan for its facilities that store petroleum products.

These efforts help achieve the following goals:

- Protect water quality Airport-wide;
- Protect groundwater resources;
- Protect surface waters (Boston Harbor) and coastal resources adjacent to the Airport;
- Minimize air quality impacts;[1]
- Protect environmental resources during construction;
- Mitigate construction impacts; and
- Reduce occurrences of fuel leaks and spills.

Massport is responsible for complying with applicable state and federal environmental laws and regulations. This chapter reports on Massport's environmental programs pertaining to environmental compliance and management and water quality, which include:

- EMS implementation;
- Sustainability Management Plan (SMP) implementation;
- Water quality and stormwater management;
- Fuel use and spills;
- Storage tank management and compliance; and
- Site assessment and remediation pursuant to the MCP.

Table 8-1 provides a progress report of environmental compliance and management efforts in 2017. The progress report summarizes Massport's mechanisms for implementing its environmental management goals and details where changes to these efforts occurred in 2017.

1 Air quality conditions are reported in Chapter 7, *Air Quality/Emissions Reduction*.

Table 8-1 Progress Report for Environmental Compliance and Management

Plan Elements	Progress Report for 2017
Environmental Compliance Inspections	In 2017, Massport performed tenant inspections at a number of its National Pollutant Discharge Elimination System (NPDES) co-permittees' (Logan Airport tenants) leaseholds and made recommendations on how to rectify issues identified during the inspections.
Environmental Management System (EMS) and International Organization for Standardization (ISO) 14001	ISO 14001 certification began for Facilities II (vehicle maintenance, landscaping, snow removal, and vehicle storage) in December 2006. In 2010, Massport expanded the Logan Airport EMS to include Facilities I (Central Heating and Cooling Plant, and heating, ventilation, and air conditioning [HVAC]) and Facilities III (electrical, structural, Central Stockroom, fuel island, and sign shop). The most recent certification audit took place in June 2017, and a certificate was issued in July 2017, which is valid through July 2020.
Tenant Technical Assistance	Massport continued publication of the *Sustainable Massport* newsletter, which informs tenants of sustainability initiatives, upcoming events, environmental compliance updates/reminders, safety tips, and best management practices (2017 and 2018 newsletters are provided in Appendix J, *Environmental Compliance and Management/Water Quality)*.
Stormwater Pollution Prevention Plan (SWPPP)	In accordance with the requirements of the current NPDES stormwater permit for Logan Airport issued on July 31, 2007, Massport and the 23 co-permittees were required to develop SWPPPs. Massport completed its SWPPP in December 2007 with annual updates since that time. Massport and the co-permittees are in the process of renewing the NPDES permit. An application for permit renewal was submitted to the U.S. Environmental Protection Agency (EPA) and the Massachusetts Department of Environmental Protection (MassDEP) in January 2012. The permit application was determined to be administratively complete and the 2007 permit remains in effect until the renewed permit is issued. The most recent update to the SWPPP was completed in October 2017 and distributed to Massport and its stormwater co-permittees at its annual update meeting. Massport's SWPPP addresses stormwater pollutants in general, deicing and anti-icing chemicals, potential bacteria, fuel and oil, and other sources of stormwater pollutants. Best management practices (BMPs) are included in the SWPPP. In accordance with the other requirements of the NPDES permit, Massport conducts training for personnel responsible for implementing activities identified in the SWPPP. The 2017 Annual Certificates of Compliance were submitted jointly to the EPA and MassDEP in December 2017 by Massport and the co-permittees.

Table 8-1 Progress Report for Environmental Compliance and Management (Continued)

Plan Elements	Progress Report for 2017
Design and Construction	Massport developed Sustainable Design Standards and Guidelines (SDSGs) for use by architects, engineers, and planners for Massport capital improvement projects in 2009.[1] The SDSGs are designed to evolve over time and foster innovation yet include clear targets to achieve more sustainable and resilient project design and practices. In addition to the SDSGs, Massport aims to construct buildings at Logan Airport to achieve U.S. Green Building Council's (USGBC's) Leadership in Energy and Environmental Design (LEED®) Silver certification or higher. Massport requires contractors to comply with the EPA Construction General Permit for all construction projects impacting one or more acres. For smaller projects, Massport requires compliance with the BMPs in the Logan Airport SWPPP. For all construction projects, Massport requires the use of ultra-low-sulfur diesel fuel in construction equipment, recycling of all construction waste to the maximum extent possible, and construction equipment retrofits with pollution control devices such as diesel oxidation catalysts and/or particulate filters.
Spill Prevention Control and Countermeasure (SPCC) Plans[2]	Massport maintains an SPCC plan for its facilities that store petroleum products. Tenants meeting certain thresholds are required to prepare their own SPCC plans for their facilities. Massport checks for SPCC plans during environmental compliance inspections. Additionally, tenants receive information on Massport BMPs, which focus on spill management and prevention.

Source: Massport.
1 More information on the SDSGs is provided in Chapter 1, *Introduction/Executive Summary*.
2 In accordance with the Clean Water Act, 40 Code of Federal Regulations 112, Oil Pollution Prevention.

International Organization for Standardization (ISO) 14001 Certified Environmental Management System (EMS)

Since 2006, Massport has had an ISO 14001 certified EMS in place, a systematic approach that Massport uses to promote continual improvement of environmental management at Logan Airport's aviation facilities. The goals of Massport's EMS are to meet regulatory requirements and to improve Massport's environmental performance beyond compliance on an ongoing basis.

The EMS consists of policies, procedures, and records that are collectively used by Massport employees to prevent pollution and address potential environmental impacts associated with Airport operations. Responding to environmental regulations and international standards, Logan Airport's EMS provides a structure for regulatory compliance and monitoring of a wide range of activities at the Airport that affect the environment, such as air quality, recycling, stormwater pollution prevention, and energy use.

Logan Airport Sustainability Management Plan (SMP)

In 2015, Massport completed the Logan Airport SMP through a grant awarded by the Federal Aviation Administration (FAA). The SMP is integrated with the existing EMS framework to promote environmental, social, and economic improvement. The completion of the SMP demonstrates Massport's leadership and commitment to a sustainable future for Logan Airport and its surrounding communities. The plan builds on Massport's rich

history of advancing sustainability and serves as a roadmap for prioritizing initiatives and moving goals forward. The SMP is intended to guide Massport's sustainability practices and supports Massport's ongoing commitment to environmental stewardship.

The SMP represents the combined efforts of over 125 employees and tenants who came together to establish Massport's baseline sustainability performance, shape goals, and identify new sustainability initiatives. Massport is focused on a holistic approach with an emphasis on economic viability, operational efficiency, natural resource conservation, and social responsibility. As part of the SMP process, Massport developed a sustainability mission statement:

> *"Massport will maintain its role as an innovative industry leader through continuous improvement in operational efficiency, facility design and construction, and environmental stewardship while engaging passengers, employees, and the community in a sustainable manner."*

Most recently, Massport published the *Massport Annual Sustainability and Resiliency Report* in April 2018. The report highlights achievements and progress toward Massport's sustainability goals and targets since the release of the SMP in 2015 and the publication of the *Annual Sustainability Report* in 2016. Massport has achieved three sustainability targets for energy use per square foot, energy use per passenger, and greenhouse gas emissions per passenger. Massport has also enhanced 60 percent of its critical assets at Logan Airport with resiliency measures, surpassing its 2020 resiliency target of 25 percent.

Massport has published five consecutive *Sustainable Massport* calendars (2015 through 2019), which highlight Massport's sustainability successes. Massport's most recent *Annual Sustainability and Resiliency Reports* and *Sustainable Massport* calendars can be viewed on Massport's website at the following address: http://www.massport.com/massport/business/capital-improvements/sustainability/sustainability-management/.

Water Quality and Stormwater Management in 2017

Massport's primary water quality goal is to prevent or minimize pollutant discharges in stormwater, thus limiting adverse water quality impacts associated with Airport activities to Boston Harbor. Massport employs a multitude of programs that promote awareness of Massport and tenant activities, which support improved surface and groundwater quality. Programs include: implementing best management practices (BMPs) for pollution prevention by Massport, its tenants, and its construction contractors; staff and tenant training; a comprehensive SWPPP; and project-specific construction SWPPPs.

The Clean Water Act of 1972 requires permits for pollutant discharges into U.S. waters from point sources and for stormwater discharges associated with industrial activities. Massport holds permits under the U.S. Environmental Protection Agency's (EPA's) and the Massachusetts Department of Environmental Protection's (MassDEP's) NPDES Program. The individual NPDES permit covers Massport and its co-permittees at Logan Airport. It establishes effluent limitations and monitoring requirements for discharges from specified stormwater outfalls.

On July 31, 2007, EPA and MassDEP issued an individual NPDES Stormwater permit for Logan Airport (NPDES Permit MA0000787). The permit became effective on September 29, 2007, replacing the previous NPDES Permit dated March 1, 1978. The NPDES permit can be found on EPA's website at: https://www3.epa.gov/region1/npdes/logan/pdfs/finalma0000787rtc.pdf. The permit remains in effect until the new permit is issued by the EPA. Massport holds a separate NPDES permit for the Fire Training Facility (NPDES Permit MA0032751). The following sections describe the requirements of the two permits and Massport's compliance with these requirements.

Stormwater Outfall NPDES Permit Requirements and Compliance

The following sections describe stormwater outfalls that are subject to the NPDES Permit No. MA0000787, the monitoring requirements, and the monitoring results for 2017.

NPDES Permitted Outfalls

The NPDES permit regulates stormwater discharges from all Logan Airport outfalls including the North, West, Northwest, Porter Street, and Maverick Street Outfalls, and airfield outfalls. The acreages associated with each outfall are: North Outfall Drainage Area (152 acres); West Outfall Drainage Area (449 acres); Northwest Outfall Drainage Area (23 acres); Porter Street Outfall Drainage Area (182 acres); Maverick Street Outfall Drainage Area (34 acres); and Airfield Outfall Drainage Areas (A1 through A44), which drain the remainder of the airfield including runways, taxiways, and the perimeter roadway (910 acres). The North and West Outfall Drainage Areas also drain a portion of the airfield. These drainage areas are shown in **Figure 8-1** and further described in **Table 8-2**. The North and West Outfalls have end-of-pipe pollution control facilities to remove debris and floating oil and grease from stormwater prior to discharge into Boston Harbor.

Table 8-2 Stormwater Outfalls Subject to NPDES Permit Requirements

Outfall Name and Number	Drainage Area (Acres)	Boston Harbor Discharge Location	Major Land Uses
North (001)	152	Wood Island Bay	Terminal E, apron, taxiway, cargo areas, fuel farms, and runways
West (002)	449	Bird Island Flats	Taxiways, terminal areas, aprons, cargo areas, runways, and roadways
Porter Street (003)	182	Bird Island Flats	Hangars, vehicle maintenance facilities, cargo areas, and car rental facilities
Maverick Street (004)	34	Jeffries Cove	Car rental facilities, bus/limousine pools, and parking areas
Northwest (005)	23	Wood Island Bay	Flight kitchens and bus maintenance facility
Airfield (A1 through A44)[1]	910	Perimeter of Airfield	Runways, taxiways, perimeter roadways, fire training facility, and Massport Fire/Rescue Station 2

Source: Massport.

1 In accordance with the requirements of the NPDES permit, Massport developed an *Airfield Stormwater Outfall Sampling Plan* (March 27, 2008). The plan requires quarterly wet weather sampling at a minimum of seven of the airfield outfalls (A1 through A44) to obtain representative samples of the quality of stormwater runoff from the airfield.

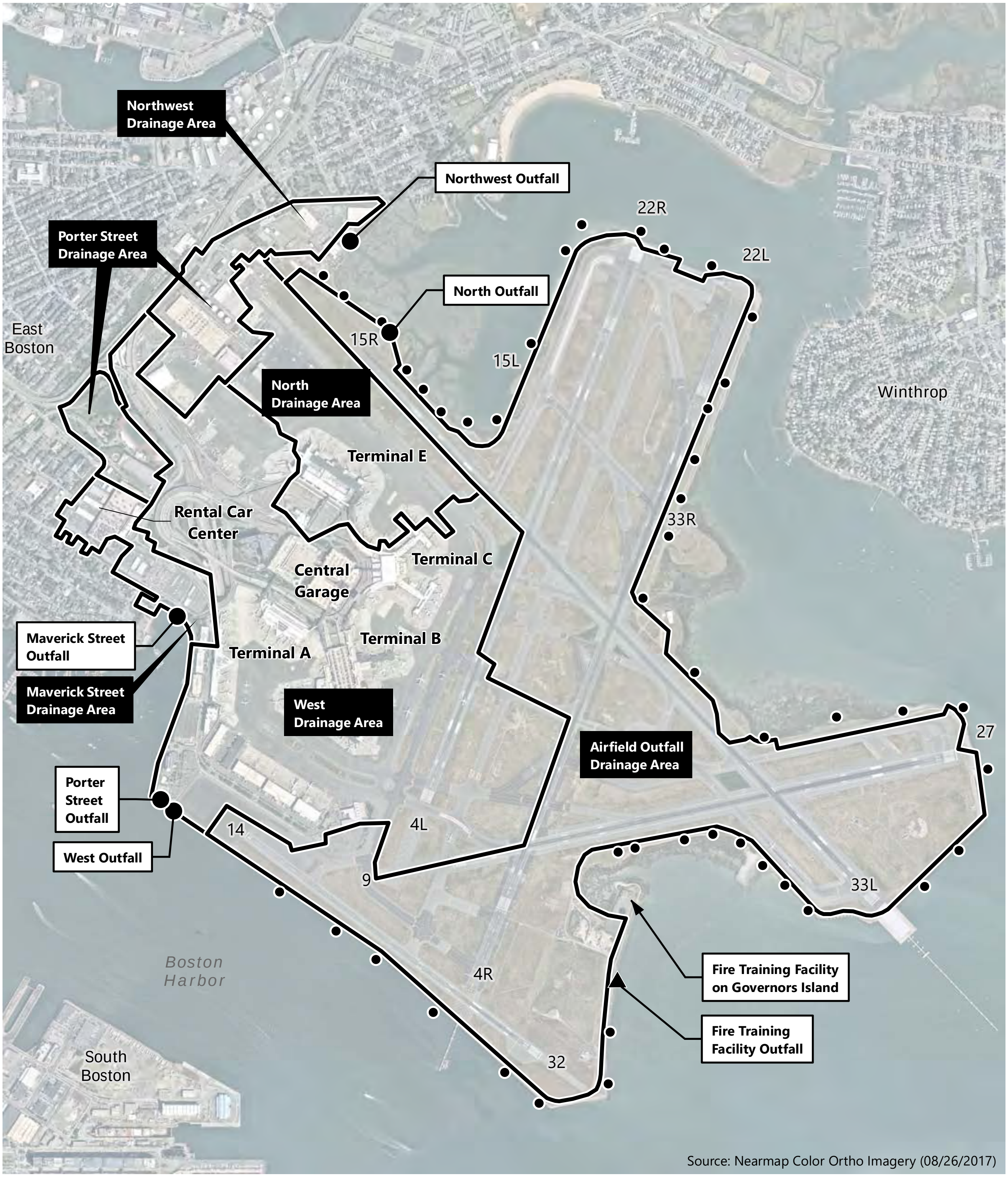


FIGURE 8-1 Logan Airport Outfalls

2017 Environmental Status and Planning Report

Monitoring Requirements

The NPDES permit (No. MA0000787) requires grab samples (single samples collected from outfall-specific locations during low tide) to be taken monthly from the North, West, Porter Street, and Maverick Street Outfalls. Samples are tested for pH, oil and grease, total suspended solids (TSS), benzene, surfactants, fecal coliform bacteria, and *Enterococcus* bacteria during both wet and dry weather. Grab samples are also taken quarterly from these four outfalls during wet weather events to analyze for eight distinct polycyclic aromatic hydrocarbons (PAHs).

Additional NPDES permit sampling requirements include sampling for deicing compounds twice per deicing season (October through April) at the North, West, and Porter Street Outfalls. The NPDES permit sets discharge limitations for pH, oil and grease, and TSS from the North, West, and Maverick Street Outfalls and for pH from the Porter Street Outfall. The NPDES permit does not include discharge limitations for the Northwest Outfall, airfield outfalls, or the deicing monitoring, and requires only that the sampling results be reported. The NPDES permit also does not set discharge limitations for bacteria, surfactants, benzene, or PAHs for any of the outfalls; sampling results for these parameters require reporting only. Appendix J, *Environmental Compliance and Management/Water Quality,* contains additional information on the sampling requirements of the NPDES permits.

2017 Monitoring Results

In 2017, 100 percent of stormwater samples were in compliance with standards for pH, oil and grease, and TSS (refer to **Table J-15** in Appendix J, *Environmental Compliance and Management/Water Quality,* for more details). Due to the large size of the drainage areas and relatively low concentration of pollutants, it is not always possible to trace exceedances to specific events. Where a known event such as a spill is reported, Massport checks the drainage system for impacts from the event and undertakes all requisite corrective actions.

The NPDES water quality monitoring results are posted on Massport's website (http://www.massport.com/massport/business/capital-improvements/sustainability/water-quality/). Massport provides copies of the monitoring results to EPA and MassDEP. The 2017 water quality monitoring results for discharge from the outfalls is provided in Appendix J, *Environmental Compliance and Management/Water Quality,* along with the history of water quality monitoring results dating back to 1993.

Deicing Monitoring

Deicing is typically conducted at Logan Airport from October or November through March or April. Deicer use is subject to the 2007 NPDES permit, which requires Massport and each airline and/or fixed base operator conducting deicing at Logan Airport to develop tailored plans to reduce deicer use. Massport and its co-permittees were actively engaged in a Deicing Management Feasibility Study to evaluate various technologies to reduce aircraft deicing fluid discharges to Boston Harbor. Massport submitted the results of the Deicing Management Feasibility Study to the EPA in May 2017.

Deicing sampling at the North, West, Porter Street, and airfield outfalls occurred during wet weather on February 1 and March 10, 2017. Sampling results are reported as required to the EPA and MassDEP and listed in Appendix J, *Environmental Compliance and Management/Water Quality* (see **Tables J-13** through **J-14** for deicing monitoring results).[2]

Stormwater and Sanitary Sewer System Inspections and Repairs

Between 2006 and 2008, Massport conducted inspections of the sanitary sewer and stormwater drainage system serving Logan Airport to document the condition of the systems and identify potential impacts from the sewer to the stormwater drainage system. Such impacts could result from leaks or breaks from the sanitary sewer or from direct, inadvertent, illegal cross-connections to the stormwater drainage system. As a result of these surveys, the Boston Water and Sewer Commission (BWSC) and Massport completed replacement of sections of the sanitary sewer system as detailed in previous environmental documents.

Massport's Facilities Department continues its inspection and cleaning of manhole and catch basin structures at locations throughout the Airport. The drainage system maintenance program also includes inspection and cleaning of Stormceptor water quality control structures. In accordance with Part I.B.10.h. of the Logan Airport NPDES Permit, the inspection and cleaning activities focus on manhole and catch basin structures within 100 yards of aircraft, vehicle, and equipment maintenance facilities.

Drainage structures, including catch basins and manholes, were inspected and cleaned as needed. A total of 58 Stormceptor units were inspected from February 22 to March 9, 2017. The maximum depth of sediment measured in the units was 10 inches. None of the Stormceptor units were found to contain sediment depths that required cleaning; however, each unit was cleaned, and any limited accumulated sediment was removed. Less than 5 cubic yards of sediment was removed from the units. From October 17 to November 1, 2017, the Stormceptor units were again inspected. The maximum depth of sediment measured was 16 inches, which occurred at one unit, and none of the Stormceptor units contained sediment depths that required cleaning.

2017 Bacteria Source Tracking

Massport continues to monitor bacteria levels at stormwater outfalls by obtaining samples during wet weather and dry weather events for laboratory analysis. Review of the analytical data indicates that bacteria levels continue to be highly variable, with no consistent trends that would indicate an ongoing source such as a cross-connection to a sanitary sewer line. Sampling results are available in Appendix J, *Environmental Compliance and Management/Water Quality.*

Fire Training Facility NPDES Permit Requirements and Compliance

NPDES Permit No. MA0032751 regulates treated wastewater surface water discharges to Boston Harbor from the Fire Training Facility on Governors Island (**Figure 8-1**).[3] This Permit is effective on the signature date (August 15, 2014) and expires on July 31, 2019. The treated wastewater from fire training exercises is stored, treated by separation and a carbon filter to remove fuel contaminants, and is typically reused

2 Wet weather deicing monitoring was only required during the first and third year of the NPDES permit.

3 NPDES Permit No. MA0032751 - Logan International Airport Fire Training Facility. Issued August 15, 2014.

onsite to recharge the fire training pit for training exercises. If no storage is available, treated wastewater is tested prior to discharge to the storm sewer to ensure compliance with the Fire Training Facility's NPDES Permit. Discharge monitoring reports are submitted monthly to the EPA. In 2017, Massport discharged treated wastewater to Boston Harbor on three separate days (November 20 and 29, and December 5). The total gallons of treated wastewater discharged were 18,500 gallons, 18,880 gallons, and 18,480 gallons, respectively, at a rate of 80 gallons per minute. A composite sample was collected from each batch of treated wastewater and compliance with permit limits were confirmed before each batch of treated wastewater was discharged to Boston Harbor. An annual whole effluent toxicity testing was also performed during the discharge event on November 20, 2017 as required by the permit.

Fuel Use and Spills in 2017

Management of fueling operations at Logan Airport is designed to minimize impacts on water quality by implementing SWPPP BMPs, including the use of reliable storage, secondary containment, and effective spill cleanup procedures. Massport's jet fuel storage and distribution infrastructure, installed in 2000 and 2001, includes a zoned leak detection system for underground fuel piping, which identifies volumetric changes of product in the pipe at operating pressure and zero pressure. The system combined the storage facility with a hydrant fuel system that reduced the need for trucks and dispensing.

The fuel storage and distribution system was designed to ensure the reliable detection of leaks to the extent technologically feasible. The consolidated above ground jet fuel storage facility and distribution system are leased and operated by BOSFuel Corporation, an airline consortium. The management of the facility by one entity was put in place to minimize potential fuel spills and maximize water quality protection for the storage and distribution facilities. Cathodic protection, leak detection, secondary containment, and tank overfill protection methods such as alarms, inventory-gauging sensors in the tanks, and emergency fuel shut-off systems have been installed. Built-in environmental controls, unified operations, and the ongoing contingency planning provide heightened environmental protection and more efficient fuel handling operations.

The Massport Fire Rescue Department keeps logs of all spills at Logan Airport (see **Table 8-3**). State environmental regulations require that oil spills of 10 gallons or more in volume be reported to MassDEP. Spills that enter storm drains of any volume must also be reported to MassDEP. Massport keeps records of all spills, including those less than the reporting threshold. In 2017, of the oil and hazardous material spills reported to the Massport Fire Rescue Department, eight spills (4.5 percent) were reportable to MassDEP due to their volume. Of the eight reportable spills in 2017, 50.0 percent of the spills were from commercial airlines, 12.5 percent from fixed base operators' equipment, 25.0 percent from Massport, and 12.5 percent from aircraft fueling. By volume, jet fuel spills accounted for 13.6 percent of total fuel spilled; diesel fuel accounted for 2.6 percent; hydraulic oil accounted for 4.4 percent; gasoline accounted for 0.6 percent; and other accounted for 78.8 percent (this includes deicing fluids). During 2017, two fuel spills entered the storm drainage system, down from five spills in 2016.

A summary of Logan Airport jet fuel usage and spill records from 1990 to 2017, as well as details pertaining to type and quantity of the spills, can be found in Appendix J, *Environmental Compliance and Management/Water Quality*.

Table 8-3 Logan Airport Oil and Hazardous Material Spills and Jet Fuel Handling[1]

Year	Total Number of all Spills	Total Number of all Spills ≥10 gallons	Total Volume of all Spills (Gallons)	Estimated Volume of Jet Fuel Handled (Gallons)	Total Volume of Jet Fuel Spilled (Gallons)
2010	87	15	476	335,693,997	360
2011	108	12	572	340,421,373	337
2012	132	5	593	343,731,127	439
2013	94	6	452	349,397,940	351
2014	129	17	2,785	370,222,342	785
2015	196	16	1,278	374,985,216	885
2016	231	14	1,158	456,003,328	558
2017	176	8	2,310[2]	472,229,047	315

Source: Massport Fire Rescue and Massport Environmental Management.
1 Material spills include: jet fuel, hydraulic oil, diesel fuel, gasoline, and other materials such as glycol and paint.
2 1,750 gallons of deicing fluid spill in January 2017.

Tank Management Program

In 2016, Massport and its tenant tank owners continued to comply with new state storage tank regulations, which can be found through the MassDEP Underground Storage Tank (UST) Program.[4] These new regulations transferred jurisdiction of all USTs from the Massachusetts Department of Fire Services (DFS) to MassDEP. Jurisdiction of all aboveground storage tanks (ASTs) with capacity volumes greater than 10,000 gallons remains with the DFS, and those ASTs with less than a 10,000-gallon capacity are now under local Massport Fire Department jurisdiction. There are three ASTs at Logan Airport with volumes greater than 10,000 gallons. Two of these tanks are located in the North Service Area and contain potassium acetate runway deicing fluid. The third tank is located at the Central Heating Plant and is used for the storage of heating oil. As a BMP, Massport continues to monitor tank systems, upgrade facilities, and remove tanks as needed. Compliance with the new tank regulations included:

- Re-permitting all ASTs using a newly created Massport Fire Department tank permit;[5] and
- Updating and tracking AST permit status, using the Massport AST database.

---

4 310 Code of Massachusetts Regulations 80.00.

5 Although aboveground storage tanks (ASTs) with a capacity of less than 10,000 gallons are no longer under the jurisdiction of the Massachusetts Department of Fire Services, the tanks are still subject to the Massachusetts fire regulations. The ASTs with a capacity of less than 10,000 gallons are now under the jurisdiction of the Massport Fire Department. Each tank requires a permit from the Massport Fire Department, which does not expire unless the tank is moved to a different location. ASTs with capacity of over 10,000 gallons need to obtain both an annual permit from the Massport Fire Department and the required permit from the Massachusetts Department of Fire Services.

Massport implements a tank management program that includes:

- A continuing program of monthly inspections, testing, and minor repairs of all Massport-owned tanks, related piping, tank monitoring systems, and related equipment.
- Annual Stage I Vapor Recovery testing, which was conducted in 2017 for Massport's gasoline USTs and piping systems at the Airport. Massport personnel were trained on the proper operation and inspection of the Stage I systems. Stage I vapor recovery involves the recovery of vapors from the gasoline tank by the tanker truck when deliveries occur. Stage I systems will continue to be operated, maintained, and tested on an annual basis.
- Annual DFS inspections of Massport's ASTs greater than 10,000 gallons in volume, and submittal of the inspection documentation to DFS.
- Review of all proposed tenant tank upgrades, installations, and tank removals (under Massport's Tenant Alteration Application process[6]) to ensure compliance with applicable state and federal regulations and with Massport policy.
- Ongoing upgrade and maintenance of a database that contains information on all USTs located on Massport property. For each tank, the database tracks location, permit status, third party inspection status, compliance status with applicable tank regulations, and tank and monitoring system equipment summaries. Information on ASTs is kept in a separate database developed in 2010.
- Information provided to tenants regarding the revised storage tank regulatory requirements and assistance with tenants' tank permitting procedures.

Site Assessment and Remediation

Massport complies with the MCP by monitoring fuel and oil and hazardous materials spills and tracking the status of spill response actions. The MCP (310 Code of Massachusetts Regulations 40 et seq.) lays out a set of regulations that govern the reporting, assessment, and cleanup of spills of oil and hazardous materials in Massachusetts. The MCP, which is administered by MassDEP, prescribes the site cleanup process based on the nature and extent of a release's contamination. The MCP defines the roles for those parties affected by and potentially responsible for the release, and establishes the release reporting program and submission deadlines for tracking events from initial release to regulatory closure.

In accordance with the MCP, Massport assesses, remediates, and brings to regulatory closure areas of subsurface contamination. There are several phases of investigation for contaminated sites. Phase I involves initial site investigations for the presence of contamination and Phase II comprehensive site investigations include site-focused risk assessments. Phase III identifies, evaluates, and selects remediation actions and Phase IV involves the implementation of selected remedial actions. Phase V involves the operation, maintenance, and/or monitoring of the remediation program. Massport undertakes the performance of a variety of response actions, including remediation at sites where Massport is the responsible party, where there are multiple responsible parties, and where no responsible party has been identified. **Table 8-4** describes Massport's progress in 2017 in achieving regulatory closure of the MCP sites identified in **Figure 8-2**. Detailed information for sites that have achieved regulatory closure can be found in **Table J-18** in Appendix J, *Environmental Compliance and Management/Water Quality*.

6 The Tenant Alteration Application is an internal Massport process for tenants who want to make modifications to their leasehold.

FIGURE 8-2 **Massachusetts Contingency Plan Sites (Active)**

2017 Environmental Status and Planning Report

1. Fuel Distribution System (3-1287)
2. Fire Training Facility (3-28199)

Table 8-4 Status of Massachusetts Contingency Plan (MCP) Active Sites at Logan Airport

Location (RTN) and MassDEP Reporting Status	Action/Status
1. Fuel Distribution System (FDS) (3-1287) - OPEN	
2011	A Periodic Review of the Temporary Solution for the FDS was submitted in April 2011. Three Post-Class C Response Action Outcome (RAO) Status Reports were submitted for the FDS in February, June, and December 2011, summarizing the routine inspection and monitoring activities.
2012	Post-Class C RAO Status Reports were submitted in May and November 2012, summarizing the routine inspection and monitoring activities.
2013	Post-Class C RAO Status Reports were submitted in May and November 2013, summarizing the routine inspection and monitoring activities.
2014	Post-Class C RAO Status Reports were submitted in May and November 2014, summarizing the routine inspection and monitoring activities. In addition, a Release Abatement Measure (RAM) Plan was submitted in April 2014 to address construction in the area of the FDS followed by a RAM Completion Report submitted in August 2014.
2015	Post-Temporary Solution Status Reports were submitted in May and November 2015, summarizing the routine inspection and monitoring activities.
2016	RAO-C 5-year periodic review submitted in July 2016. Two Post-Temporary Solution Status Reports were submitted in 2016 summarizing the routine inspection, monitoring, and product recovery activities.
2017	Tier II Extension transmitted in August 2017 for response actions conducted at Terminal B subsequent to filing a Temporary Solution. A Final Permanent Solution Statement was submitted for Areas 3 and 5 in December 2017.
2. Fire Training Facility (3-28199) – OPEN	
2011	A RAM Completion Statement was submitted on April 25, 2011. A Phase II Scope of Work was prepared and submitted to MassDEP on January 18, 2011. Phase II and Phase III Reports were submitted on December 8, 2011. A RAM Completion Statement was submitted on April 25, 2011.
2012	Phase 4 Status Report transmitted in June 2012; the Phase IV Remedy Implementation Plan was submitted in December 2012.
2013	Phase 4 Status Report transmitted in June 2013, the Phase IV Completion Report was transmitted in December 2013.
2014	Phase 5 Remedy Operation Status Reports submitted in June and December 2014.
2015	Phase 5 Remedy Operation Status Reports submitted in June and December 2015.
2016	Phase 5 Remedy Operation Status Reports submitted in June and December 2016.
2017	Phase 5 Remedy Operation Status Reports submitted in June and December 2017.

Source: Massport.
Notes: RTN = Release Tracking Number. This list includes active Massport MCP sites only. Additional sites are the responsibility of Logan Airport tenants. Refer to **Figure 8-2** for location of active MCP sites. Complete information dating back to 1997 on closed sites is included in Appendix J, *Environmental Compliance and Management/Water Quality*.
Phase I Initial Site Investigation
Phase II Comprehensive Site Assessment
Phase III Identification, Evaluation, and Selection of Comprehensive Remedial Actions
Phase IV Implementation of Selected Remediation Action
Phase V Operation, Maintenance, and/or Monitoring

9

Environmentally Beneficial Measures and Project Mitigation Tracking

Introduction

This chapter of the *Logan Airport 2017 Environmental Status and Planning Report (ESPR)* summarizes the Massachusetts Port Authority's (Massport's) environmentally beneficial measures associated with Boston Logan International Airport (Logan Airport or the Airport). It also provides an update on Massport's mitigation commitments under the Massachusetts Environmental Policy Act (MEPA) for projects at Logan Airport for which an Environmental Impact Report (EIR) was filed and state Section 61[1] Findings were committed in order to document that all feasible measures have been taken to avoid or minimize impacts. Massport actively and continuously seeks to avoid or minimize environmental effects associated with projects and operations at Logan Airport.

The first part of this chapter provides an overview of Massport's programs and initiatives that provide environmental benefits. The second part provides updates for specific projects with ongoing or upcoming Section 61 mitigation commitments, as documented in **Tables 9-1** through **9-8**. Projects for which mitigation has been completed are not reported in Environmental Data Reports (EDRs) and ESPRs. Once projects with ongoing requirements are constructed, mitigation tracking reports only on the continuing requirements. Each project discussed below completed state and federal environmental review and adopted a mitigation plan that has been formalized with individual Section 61 Findings. Massport tracks both Massport and Logan Airport tenants' progress toward implementing and meeting their environmental mitigation commitments on schedule and in accordance with the requirements set out in the Section 61 Findings for each project. As each project moves forward through its design and construction phases, its mitigation plan is implemented with ongoing tracking to ensure compliance.

Environmentally Beneficial Measures

Massport is committed to minimizing the effects of Airport operations on the community and environment by implementing a robust set of initiatives Airport-wide for the benefit of the traveling public, Airport users, and neighbors. These include the following environmentally beneficial measures:

- **High Occupancy Vehicle (HOV) Strategy.** Massport has a comprehensive, multi-pronged strategy to diversify and enhance ground transportation options for passengers and employees traveling to and from Logan Airport. The ground transportation strategy is designed to expand capacity and maximize

1 Massachusetts General Law, Chapter 30, Section 61 (M.G.L. c. 30, § 61).

the use of HOV, transit, and shared-ride options that are convenient and reliable, and that reduce environmental and community impacts. Massport continues to promote and support HOV and shared-ride services to improve operations along terminal-area roadways and at curbside areas, alleviate constraints on parking, improve customer service, and minimize emissions.

Massport is currently evaluating a number of strategies to improve and expand HOV service to and from Logan Airport, which include continued investment in Logan Express facilities and service. Given the recent increase of transportation network companies (TNCs, such as Uber and Lyft) travel modes to and from Logan Airport, Massport has a goal to double Logan Express ridership from 2 million to 4 million passengers, thereby reducing vehicle miles traveled (VMT), congestion, and air quality emissions. Massport is expanding its Logan Express services, evaluating new Logan Express locations, planning to add additional spaces to the Framingham garage and Braintree site, reducing fares at the Back Bay site, and providing free service from Logan Airport to Back Bay. Additionally, Massport plans to purchase eight additional Silver Line buses, increasing the fleet size to 16 buses serving Logan Airport. More information can be found in Chapter 5, *Ground Access to and from Logan Airport*.

- **TNC Management.** As TNCs have become an increasingly popular option for travelers getting to and from Logan Airport, Massport has and will continue to develop strategies to facilitate efficient operation of all modes of ground transportation. In an effort to reduce congestion and emissions, Massport has a robust plan to manage TNC operations and reduce TNC deadhead activity.[2] Massport's plan includes a rematch[3] and shared ride program, TNC fee structure changes to encourage shared rides and competition between modes, and optimization of TNC operations on-Airport, including a centralized drop-off/pick-up location to better achieve rematch. For more detailed information on Massport's TNC management plan, please see Chapter 5, *Ground Access to and from Logan Airport*.
- **Long-Term Parking Management Plan.** Massport continues to manage parking supply, pricing, and operations to promote the use of HOV, transit, and shared-ride options and to reduce drop-off/pick-up modes. As air traveler numbers have increased, the legally-constrained parking supply at Logan Airport, resulting from the Logan Airport Parking Freeze,[4] has often had the unintended consequence of causing an increase in environmentally harmful drop-off/pick-up vehicle trips, which generate up to four vehicle trips instead of two.[5] In accordance with the modified Logan Airport Parking Freeze approved by the Massachusetts Department of Environmental Protection (MassDEP) and the U.S. Environmental Protection Agency (EPA) to allow for an additional 5,000 commercial parking spaces at Logan Airport, Massport is advancing plans for constructing 2,000 spaces in a new garage in front of Terminal E and a 3,000-space expansion of the Economy Garage.

2 Deadhead trips are those trips to or from the Airport that do not contain a passenger.

3 Rematch allows drivers who are dropping off to instantly pick up another passenger without needing to circle the Airport or leave empty.

4 310 Code of Massachusetts Regulations 7.30 and 40 Code of Federal Regulations 52.1120.

5 Drop-off/pick-up modes can include private vehicles, taxis, transportation network companies (TNCs), and black car limousine services. For example, if an air passenger is dropped off when departing on an air trip and is picked up upon return, that single air passenger generates a total of four ground access trips: two for the drop-off trip (one inbound to Logan Airport, one outbound from Logan Airport) and two for the pick-up trip (one inbound to Logan Airport, one outbound from Logan Airport). The air passenger may be dropped off and picked up in a private vehicle or in a taxi, TNCs, or a black car limousine that may not carry a passenger during all segments of travel to and from Logan Airport.

Massport has taken steps to advance three key Logan Airport ground access studies, known as the Logan Airport Parking Freeze Amendment, Ground Access, and Trip Reduction Strategy Studies. These findings will be reported in the next EDR and analyze the feasibility and effectiveness of the following:

- Potential services and improvements to HOV access;
- Potential operational measures to further reduce drop-off/pick-up modes; and
- Possible pricing strategies for different modes.

More information can be found in Chapter 5, *Ground Access to and from Logan Airport*.

- **Noise Abatement and Sound Insulation.** Massport's comprehensive noise abatement program includes a dedicated Noise Abatement Office; a state-of-the-art Noise and Operations Monitoring System (NOMS); extensive residential and school sound insulation programs for those eligible under federal guidelines; time of day and runway restrictions for noisier aircraft; ground run-up procedures; and flight tracks designed to optimize over-water operations (especially during nighttime hours). Massport continues to be a national leader in sound insulation mitigation. To date, Massport has provided sound insulation for a total of 36 eligible schools and 11,515 residential units and will continue to seek funding for mitigation for properties that are eligible and whose owners have chosen to participate. These efforts and progress towards achieving noise reduction goals, can be found in Chapter 6, *Noise Abatement*.
- **Air Emissions Reduction**. Massport is a national leader in studying, tracking, and reporting on the air quality environment of Logan Airport, and implementing measures to reduce emissions. Initiatives include operating one of the largest privately operated, publicly accessible, compressed natural gas (CNG) stations in New England; providing pre-conditioned air (PCA) and 400 Hertz (Hz) power at all aircraft contact gates to reduce aircraft idling and auxiliary power unit (APU) use when not enough gates are available; and a commitment to sustainable design. More information can be found in Chapter 7, *Air Quality/Emissions Reduction*.
- **Electric Ground Service Equipment (eGSE).** As part of the ongoing Alternative Fuel Program, Massport is facilitating the replacement of gas- and diesel-powered ground service equipment (GSE) with all-electric GSE (eGSE) by the end of 2027, as commercially available. In 2018, the EPA awarded a $541,817 grant to Massport to replace certain gas- and diesel-powered GSE at Logan Airport. This grant will be used in conjunction with a Federal Aviation Administration (FAA) VALE grant Massport received in the fall of 2018 to install eGSE charging stations as part of the Terminal B Optimization Project. More information can be found in Chapter 7, *Air Quality/Emissions Reduction*.
- **Alternative Fuel Vehicles (AFV) Program.** The AFV Program is designed to replace Massport's conventionally-fueled fleet with alternatively-fueled or powered vehicles, when feasible, to help reduce emissions associated with Logan Airport operations. Massport now operates 92 vehicles powered by CNG, propane, E85 flex fuel, diesel/electric hybrid, and gasoline/electric hybrid. Massport also established a vehicle procurement policy in 2006 that requires consideration of AFVs when purchases are made. For example, beginning in 2013, as part of the Southwest Service Area (SWSA) redevelopment, the existing fleet of diesel rental car shuttle buses was replaced by CNG or clean diesel-electric hybrid buses. In 2017, two CNG Honda Civics were retired, and the remaining seven are planned for retirement in 2019. The remaining CNG pick-up trucks and vans were retired in 2018. More information can be found in Chapter 7, *Air Quality/Emissions Reduction*.

- **Open Space/Buffer Program.** Massport has invested in an extensive open space program intended to enhance the surrounding communities. Massport initially committed over $15 million for the planning, construction, and maintenance of four Airport edge buffer areas and two parks along Logan Airport's perimeter. These buffers include the Bayswater Embankment Airport Edge Buffer, Navy Fuel Pier Airport Edge Buffer, Neptune Road Airport Edge Buffer, and the SWSA Airport Edge Buffer (Phases I and II). The award-winning Piers Park was completed in 1995 and has since become part of a network of greenspace that traverses East Boston from the Jeffries Point waterfront to Constitution Beach. Adjacent to the current Piers Park, Piers Park Phase II will add approximately 4.2 acres of green space to the East Boston waterfront upon completion, and studies are underway by an outside party for a potential Piers Park Phase III, which would turn an aging pier into a 3.6-acre greenspace including resiliency features to help protect the neighborhood from flooding and sea level rise. Today, East Boston enjoys 3.3 miles and more than 33 acres of green space developed or managed by Massport, in partnership with and in response to engagement with the East Boston community. More information can be found in Chapter 3, *Airport Planning*.
- **International Organization for Standardization (ISO) 14001 Certified Environmental Management System (EMS)**. Since 2006, Massport has had an ISO 14001 certified EMS in place, a systematic approach that Massport uses to promote continual improvement of environmental management at Logan Airport's Aviation Facilities. The goals of Massport's EMS are to meet regulatory requirements and improve Massport's environmental performance beyond compliance on an ongoing basis. The EMS consists of policies, procedures, and records that are collectively used by Massport employees to prevent pollution and address potential environmental impacts associated with Airport operations. Responding to environmental regulations and international standards, Logan Airport's EMS provides a structure for regulatory compliance and monitoring of a wide range of activities at the Airport that affect the environment, such as air quality, recycling, stormwater pollution prevention, and energy use. More information can be found in Chapter 8, *Environmental Compliance and Management/Water Quality*.
- **Energy Planning.** Massport is studying opportunities to maximize solar installations across Logan Airport and installing electric vehicle infrastructure on the airside and in parking garages. Massport has installed electric charging facilities in all its garages and will also install them in the proposed new garage in front of Terminal E and the expanded Economy Garage. More information can be found in Chapter 3, *Airport Planning*.
- **Resiliency Planning.** Massport has a robust effort underway that first identified vulnerabilities on the Airport and is now incorporating resilient infrastructure design standards for all types of Airport projects. At the end of 2013, Massport initiated a Disaster and Infrastructure Resiliency Planning Study (DIRP) for Logan Airport, the Port of Boston, and Massport's waterfront assets in South and East Boston. The study was completed and implementation of adaptation initiatives began in late 2014.

  In addition to the DIRP Study and its related initiatives, Massport has completed an Authority-wide risk assessment, as part of its strategic planning initiative; issued a Floodproofing Design Guide; and has developed a resilience framework to provide consistent metrics for short- and long-term planning and protection of its critical facilities and infrastructure. Massport's Floodproofing Design Guide was published in November 2014 and updated in April 2016. Beyond infrastructure resiliency, Massport is also focused on incorporating social and economic resilience into its long-term operational and capital planning.

Operational aspects of the resiliency strategy include the development of Flood Operations Plans for Logan Airport and Massport maritime facilities. These plans were introduced in 2015 and included the planned deployment of temporary flood barriers to protect up to 12 locations of critical infrastructure in the event of severe weather. The test deployments and live event staging for the March 2018 Nor-easters succeeded in managing and tracking flood barrier deployment logistics and effective communication. As a result, Logan Airport's Flood Operations Plans and operational responses have evolved. A web-based coastal flood resiliency application was developed to better manage planning immediately prior to an event impact, and to facilitate operational recovery as quickly as possible. Additional locations have been permanently enhanced to prevent flooding.

In 2017, Massport conducted a series of workshops with key stakeholders to review and continuously improve its Flood Operations Plans. In addition, many education and training opportunities have been provided to staff and emergency responders to increase operational preparedness for flood events. In March 2018, Massport conducted several practice deployments of flood barriers at three critical Logan Airport assets. Additionally, Massport developed a flood resiliency application to inform decision-making, facilitate management oversight, and enable real-time field updates via mobile devices before, during, and after storm events. More information can be found in Chapter 3, *Airport Planning*.

- **Sustainability Planning.** Massport has a robust sustainability program and routinely educates employees through a quarterly Sustainable Massport Newsletter, which is included in Appendix J, *Environmental Compliance and Management/Water Quality*. Additionally, Massport undertakes the following sustainable initiatives:
  - The Logan Airport Sustainability Management Plan (SMP) takes a comprehensive approach to sustainability including economic vitality, social responsibility, operational efficiency, and natural resource conservation. The Logan Airport SMP is intended to promote, integrate, and coordinate sustainability efforts across the Authority. The Logan Airport SMP was developed with a framework and implementation plan, with metrics and targets designed to track progress over time. Massport is currently advancing a series of short-term initiatives to help reach its goals in the areas of energy and greenhouse gas (GHG) emissions; community, employee, and passenger well-being; resiliency; materials, waste management, and recycling; and water conservation.
  - The Massport Annual Sustainability and Resiliency Report provides a progress summary of sustainability efforts at Logan Airport, and other Massport facilities, based on Massport's sustainability goals and targets established in the Logan Airport SMP.
  - Each year since 2015, Massport distributes Sustainable Massport calendars to employees and other stakeholders. The calendars are filled with examples of Massport's sustainability projects and successes, and each month highlights aspects of environmental, social, and economic aspects of sustainability to which employees can contribute.
  - Massport is continuing to incorporate sustainability considerations into its projects and is currently working on a vision for Massport "Sustainability 2.0." The vision for this next-level planning effort is to implement principles and approaches from the Logan Airport SMP at other Massport facilities and to update Massport's sustainability goals and targets.

Projects with Ongoing Mitigation

The following section documents the status of projects with specific Section 61 mitigation commitments, in chronological order, starting with the West Garage Project to the Terminal E Modernization Project. Massport will continue to report on the status of mitigation in EDRs and ESPRs to provide a solid accounting of Massport's commitment to regulatory compliance and to provide information to the community. The status of continuing mitigation requirements is documented in this chapter.

- **West Garage Project,** Executive Office of Energy and Environmental Affairs (EEA) #9790: Phase I and Phase II construction was completed in 2007.
- **International Gateway Project**, EEA #9791: Phase I was completed in 2004; Phase II was completed in 2007; and the final phase has been changed to the Terminal E Modernization Project (EEA #15434) (see below).
- **Replacement Terminal A Project**, EEA #12096: Terminal A opened March 16, 2005.
- **Logan Airside Improvements Planning Project**, EEA #10458: Runway 14-32 opened on November 23, 2006. The Centerfield Taxiway was completed and became fully operational in 2009.
- **Southwest Service Area (SWSA) Redevelopment Program**, EEA #14137: Construction of the Rental Car Center (RCC) program began in the summer of 2010, and the first phase of the facility opened in the fall of 2013. Other phases of the project were completed in 2014.
- **Logan Airport Runway Safety Areas (RSA) Project**, EEA #14442: Construction on the Runway 33L RSA began in June 2011 and was completed in November 2012. The replacement of the Runway 33L approach light pier was completed concurrently with Runway 33L RSA construction. Construction of the Runway 22R Inclined Safety Area (ISA) was completed in the fall of 2014.
- **Terminal E Modernization Project**, EEA #15434: The project will accommodate existing and long range forecasted passenger demand for international service and will include the three gates permitted and approved as part of the International Gateway/West Concourse Project in 1996 (but never constructed), and four additional new aircraft contact gates. An Environmental Notification Form (ENF) was filed in October 2015, the Draft Environmental Assessment (EA)/EIR was filed in May 2016, and the Secretary of the EEA issued a Certificate on the Draft EA/EIR on September 16, 2016. Massport filed the Final EA/EIR on September 30, 2016. On November 10, 2016, the FAA issued a Finding of No Significant Impact (FONSI) and on November 14, 2016, a Record of Decision (ROD) for the project, indicating that Massport can now update the Airport Layout Plan (ALP) with the proposed Terminal E Modernization Project. Final design is underway (see Chapter 3, *Airport Planning,* for additional information).

West Garage Project – EEA #9790

Permitting History

- Certificate on the Final EIR issued on March 16, 1995.
- Section 61 Findings approved on March 27, 1995.

Project Status

The West Garage Project (**Figure 9-1**) was initially proposed to be constructed in two phases. Phase I of the Project provided 3,150 parking spaces that were consolidated from other areas of Logan Airport. The West Garage is directly connected to the Central Garage, centralizing the two structures' parking into a larger, single functioning, easily accessible garage. The West Garage Project also included construction of elevated walkways connecting the West Garage to Terminals A and E, and improvements to the terminal roadways. The original design of Phase II of the West Garage included the construction of a new structured parking facility adjacent to the West Garage. Instead, Massport concluded it was more cost efficient to proceed with Phase II by adding three additional levels (Levels 5, 6, and 7) to the existing Central Garage. Phase II of the West Garage Project provided approximately 2,800 additional parking spaces.

- **Phase I** – Construction commenced in October 1995 and the garage opened on September 8, 1998. The elevated walkways to the terminals were completed in 2002. Improvements to terminal roadways were completed in 2003.
- **Phase II** – Permitting was completed in 2000 to add three levels to the Central Garage. Construction commenced in 2004 and the entire facility enhancement was completed in 2007.

Table 9-1 lists each of the continuing Section 61 mitigation commitments for the West Garage Project and Massport's progress in achieving these measures. **Table 9-2** details the elements and status of the AFV Program, which was a key mitigation effort associated with the West Garage Project. **Tables 9-1** and **9-2** detail the Section 61 mitigation measures from the West Garage Project Final EIR, dated January 31, 1995, and those measures referenced in the Massport Board vote on the West Garage Project. Many of the mitigation measures for this project have long since been implemented, but it is noted in the tables when there have been recent updates.

Unrelated to this project, in late 2015, Massport completed the West Garage Parking Consolidation Project, which consolidated 2,050 temporary parking spaces as part of an addition to the West Garage and at the existing surface lot between the Logan Office Center and the Harborside Hyatt. The West Garage addition is located on the site of the existing Hilton Hotel parking lot. Construction of these spaces constituted all of the remaining spaces permitted under the Logan Airport Parking Freeze as of that date.[6] On March 20, 2014, the EEA issued an Advisory Opinion confirming no MEPA review was required for this project. Construction commenced in the spring of 2015 and was completed in 2016.

6 310 Code of Massachusetts Regulations 7.30 and 40 Code of Federal Regulations 52.1120.

FIGURE 9-1 West Garage Project

2017 Environmental Status and Planning Report

◆ West Garage Project EEA #9790

Phase I West Garage Construction
Phase II Addition to Central Garage

Table 9-1 West Garage Project Status Report (EEA #9790)
Details of Ongoing Section 61 Mitigation Measures (as of December 31, 2018)

Mitigation Measure	Status
Parking Pricing	
Parking pricing initiatives: keeping first-hour price high enough to provide a disincentive for drop-off/pick-up.	**Implemented.** Massport continues to evaluate and adjust the first-hour price of parking. In light of the security prohibition on curbside parking, in 2002 Massport reduced the cost of the first half-hour from $4 to $2, the first time it had changed since the first-hour free rate was rescinded in 1998. In June 2007, rates increased to $3 for the first half-hour. Parking rates increased in 2012, 2014, 2016, and 2017 for on-Airport parking; further details on parking rate increases are provided in **Table 5-6** of Chapter 5, *Ground Access to and from Logan Airport*.
Parking pricing initiatives: keeping the weekly price low enough to encourage vacation travelers to park for a week.	**Implemented.** Massport encourages long-term parking by providing lower cost parking at its Economy Lot and the off-Airport Logan Express lots. The long-term Parking Management Plan lays out a multi-part strategy for efficiently managing parking supply, pricing, and operations. Data on long-term parking use are provided in Chapter 5, *Ground Access to and from Logan Airport*.
Massport will consider means to encourage the use of limited amount of on-Airport commercial parking for long-term parking and promote environmentally positive modes of airport access by air passengers.	**Implemented.** An important element of Massport's strategy to reduce the impact of Airport-related traffic on regional highways and local streets in neighboring communities is the Massport Parking Pricing Policy. Massport's Parking Pricing Policy encourages long-term parking over short-term parking by charging a premium for time spent in the on-Airport parking facilities between one and four hours and substantially reducing the per hour rate for parking durations longer than four hours. This strategy has proved to be a successful incentive for passengers to drive themselves and park long-term at Logan Airport rather than having someone else drop them off or pick them up, thereby reducing the number of trips from four to two. Additional information on parking is provided in Chapter 5, *Ground Access to and from Logan Airport*. The Logan Airport Parking Project, which is currently undergoing public review, plans to provide 5,000 new on-Airport parking spaces in accordance with the amended Logan Airport Parking Freeze. A key goal of the Project is to provide parking for those passengers that would otherwise use drop-off/pick-up modes and generate a higher number of associated trips.
Once sufficient data have been collected, Massport will evaluate parking behavior that may be attributable to the modified rates and consider further adjustments in pricing that will assist in achieving Massport's ground transportation goals.	**Implemented.** Massport's parking rate structure is compatible with continued growth in long-term parking and Massport's goal to increase the total high occupancy vehicle (HOV) use by air passengers. Adjustments to hourly parking rates have been made over time to reflect usage patterns. Additional information on parking pricing is provided in Chapter 5, *Ground Access to and from Logan Airport*.
Executive Director shall report to Massport annually regarding the effectiveness of parking pricing policy in achieving Massport's ground access goals initiatives and recommend appropriate policy adjustments.	**Implemented**. Through the annual Environmental Data Report (EDR)/Environmental Status and Planning Report (ESPR) filings, Massport reports on the effectiveness of parking pricing strategies. Please refer to Chapter 5, *Ground Access to and from Logan Airport*, for additional details on Massport's parking pricing efforts.

Table 9-1 West Garage Project Status Report (EEA #9790)
Details of Ongoing Section 61 Mitigation Measures (as of December 31, 2018) (Continued)

Mitigation Measure	Status
Concurrent Ground Access Improvement Mitigation Measures	
Employee Trip Reduction Measures	
Massport will form a Transportation Management Association (Logan TMA) for Logan Airport employees to provide new opportunities for the development of targeted transportation demand management (TDM) strategies for Massport and airport tenant employees.	**Implemented.** In the 1995 Board Resolution, Massport's Executive Director was authorized to expend an initial amount of up to $50,000 for the purpose of organizing the Logan TMA. The Logan TMA was created in March 1997. Massport continues to support the Logan TDM strategies by funding the Logan Sunrise Shuttle at an annual cost of $65,000. Massport conducted a series of outreach events in 2017 for Airport employees to raise awareness of employee commute options with a focus on HOV modes.
Massport will seek to develop, coordinate, and implement effective TDM strategies to reduce the number of single-occupant trips made by all Logan Airport employees, including outreach to employees about transportation options.	**Implemented.** Massport supports TDM strategies by providing services and by periodically conducting the Logan Airport Employee Survey. The 2016 survey was summarized in the *2016 EDR* Chapter 5, *Ground Access to and from Logan Airport*. The 2019 Logan Airport Employee Survey will be discussed in the next EDR.
Massport will encourage participation by all employees, but will particularly target the Airport's largest employers.	**Implemented.** Refer to Chapter 5*, Ground Access to and from Logan Airport,* for more details on the Logan TMA.
Massport will report on the formation and activities of the Logan TMA in the next Generic Environmental Impact Report (GEIR).	**Implemented.** The current status of the Logan TMA is summarized in Chapter 5, *Ground Access to and from Logan Airport*.
Massport proposes to implement a new Logan Express service or other HOV service depending on the needs of the targeted market before Phase II of the West Garage Project is operational.	**Implemented**. The Peabody Logan Express facility opened in September 2001 (see Chapter 5, *Ground Access to and from Logan Airport,* for additional information on Peabody Logan Express). Despite modest ridership, Massport continues to operate this service. In 2014, Massport initiated the Back Bay Logan Express pilot service, which provides travelers with three scheduled trips per hour between the Hynes Convention Center, Copley Square Station, and Logan Airport. This route was established as an interim/pilot service to supplement ground access to Logan Airport while the Massachusetts Bay Transportation Authority (MBTA) Green Line station was temporarily closed for reconstruction. The new Government Center station reopened in March 2016. The Back Bay Logan Express service was relocated from Copley Square to Back Bay Station in 2019. Coincident with the relocation was a reduction in fees from downtown to Logan Airport, free boarding at Logan Airport, and preferred access to security lines for passengers. Massport is also initiating planning for additional parking at the Framingham Logan Express site (about 1,000 spaces) and the Braintree Logan Express site (about 3,000 spaces), for a total of approximately 4,000 new spaces.

Table 9-1 West Garage Project Status Report (EEA #9790)
Details of Ongoing Section 61 Mitigation Measures (as of December 31, 2018) (Continued)

Mitigation Measure	Status
Provide an airport shuttle service from South Station Transportation Center. Massport is preparing a feasibility and business plan for a South Station-Logan Airport shuttle service and will implement this service when the Third Harbor Tunnel is opened for commercial traffic. This service will be modeled on the existing, successful Logan Express services and will include frequent bus service between South Station and the airport terminals.	**Implemented.** In 1997, Massport sponsored the development of a joint public/private partnership with intercity bus operators serving the South Station Transportation Center. The service had limited success largely because of variable operator schedules and the fact that the service operates out of the South Station Transportation Center instead of a location closer to the South Station MBTA Red Line stop. Following the interim Logan DART service between Logan Airport and South Station in 2000, in June 2005, Massport and the MBTA jointly commenced full Silver Line Airport Service, providing a direct connection between South Station and each Logan Airport terminal. Refer to Chapter 5, *Ground Access to and from Logan Airport,* for additional information on the Silver Line.
Massport will regularly evaluate the frequency of, and demand for, such shuttle service and will provide such service at the greatest frequency that is practical and effective.	**Implemented.** Massport continues regular collaboration with the MBTA on the Silver Line Airport service and makes adjustments as necessary. Beginning in May 2012, Massport initiated a pilot program offering free rides on the Silver Line from Logan Airport to downtown Boston to promote HOV usage and heighten awareness of public transit options. The purpose of the program was to promote ridership, operations, and customer service. Free service from Logan Airport continues as of the date of this *2017 ESPR*. Additionally, Massport plans to purchase eight additional Silver Line buses, increasing the fleet size purchased by Massport to 16 buses.
Massport will implement a new water shuttle service in Boston Harbor before the opening of Phase I of the West Garage Project. The water shuttle would run between Logan Airport and one, or possibly more, sites in the Harbor.	**Implemented.** Massport identified a number of possible destinations for a new water shuttle service, with the Quincy Shipyard and Long Wharf sites meeting the basic service parameters. Harbor Express was chosen as the water shuttle operator and began operation between the Airport and these two sites in November 1996. Massport continues to support the City Water Taxi operations. Refer to Chapter 5, *Ground Access to and from Logan Airport,* for water shuttle ridership information.
The Executive Director shall make recommendations to Massport for budgetary appropriations to establish and implement the new ground access services on a schedule that permits Massport to implement the new ground access services within these time frames.	**Implemented.** Massport's Executive Director/CEO recommends budgetary appropriations for ground access services on an annual basis.
Enhancement of Existing HOV Services: Logan Express	
Expand Logan Express hours of service.	**Implemented.** Service is offered from Braintree as early as 2:00 AM and as late as 11:00 PM; from Framingham as early as 2:15 AM and as late as 11:00 PM; from Woburn as early as 2:15 AM and as late as 11:00 PM; and from Peabody as early as 3:15 AM and as late as 10:15 PM. Buses leave every hour or half hour. Logan Express buses now depart from Logan Airport as late at 1:15 AM. The Braintree service was expanded in 2019 to operate on 20-minute frequencies. The Back Bay Logan Express operates daily trips between the hours of 5:00 AM and 10:00 PM. The Logan Express schedule is available at http://www.massport.com/logan-airport/to-from-logan/transportation-options/logan-express/.

**Table 9-1 West Garage Project Status Report (EEA #9790)
Details of Ongoing Section 61 Mitigation Measures (as of December 31, 2018) (Continued)**

Mitigation Measure	Status
Provide a guaranteed ride home for Logan Express users.	**Implemented and subsequently modified.** From January 1995 until November 2001, Massport provided this service for air passengers and Logan TMA members. Due to financial constraints following September 11, 2001, this program was suspended for those passengers arriving after midnight with pre-purchased round-trip Logan Express tickets. Extended service now provides nearly 24-hour service at several Logan Express locations.
Provide Logan Express price incentives.	**Implemented.** Massport continues to monitor price incentives and implements additional incentives to promote Logan Express ridership, particularly during vacation periods and other periods of peak airport activity. In April 2011, Logan Express sites offered a discounted rate for parking. A survey of Logan Express passengers revealed that drop-off activity at Logan Airport was reduced and the demand for parking at Logan Airport was reduced during the period of the discounted Logan Express parking. To encourage greater ridership, Massport restructured parking rates, which lowered parking rates to $7 per day from $11 per day at Logan Express parking lots. These rates have been in effect since March 1, 2012 (and resulted in increased Logan Express passenger activity at rates greater than the rate of increase in Logan Airport air passengers). Additional seasonal and holiday promotions are also offered.
Develop an additional Logan Express service.	**Implemented.** Massport opened a fourth Logan Express in Peabody, Massachusetts in September 2001, several years before the Section 61 commitment date of the opening of Phase II of the West Garage Project. While the new service was initially planned to operate on a half-hour schedule like the Braintree, Framingham, and Woburn services, because of the dramatic air passenger reductions after September 11, 2001, (during Peabody's first week of service), to cut costs, Massport operated the Peabody Logan Express on hourly frequencies. In January 2004, in light of low levels of ridership on the Peabody Logan Express, Massport doubled service by going to a half-hourly schedule in an effort to stimulate ridership growth at Peabody. The service now operates on an hourly weekday schedule. In 2014, Massport initiated an interim Back Bay Logan Express pilot service, which provides travelers with three scheduled trips per hour between the Hynes Convention Center, Copley Square Station, and Logan Airport. The Back Bay Logan Express service was relocated from Copley Square to Back Bay station in May 2019, along with discounted one-way fares and free service from Logan Airport. Security line priority status to Logan Express Back Bay riders is also provided. Massport is evaluating a new urban Logan Express location (North Station or similar location), and potential additional locations in Metro West and on the North Shore.
Enhancement of Existing HOV Services: Water Transportation	
In conjunction with the MBTA, Massport will pursue joint ticketing opportunities for the Hingham Commuter Boat and the Logan Airport Water Shuttle.	**Implemented.** This ticketing program was implemented in mid-1995 and discontinued in 2000 since many of the former users of the program used the Harbor Express Service direct from Quincy to Logan Airport at that time. Service is now provided from Hingham and Hull directly to Logan (via Long Wharf).

**Table 9-1 West Garage Project Status Report (EEA #9790)
Details of Ongoing Section 61 Mitigation Measures (as of December 31, 2018) (Continued)**

Mitigation Measure	Status
Massport is reviewing the fee schedules and operating requirements of the dock to make it more accessible and convenient to potential water taxi operators.	**Implemented.** In the fall of 1995, Massport made physical improvements to a low-freeboard float at the Logan Airport Dock to create a dock capable of accommodating smaller vessels such as water taxis. In the fall of 2002, Massport completed expansion of the Harborside Dock to accommodate the demand of additional vessels and to comply with handicapped accessibility requirements. The improved dock increases capacity from a two-float system to a seven-float system to accommodate the various water shuttles, taxis, and charter boats that are licensed to use it. Massport continues to provide free on-Airport shuttle service to the water shuttle dock.
Initiate a new Boston Harbor Water shuttle service.	**Implemented.** Harbor Express service, between Logan Airport and the South Shore, began in November 1996, well before the opening of Phase I of the West Garage in September 1998. In 2001, the MBTA took over operations of this service.
Expand docking capacity at Logan Airport for water taxi and other services.	**Implemented.** Massport accommodates water taxi services, enhanced the dock as described above, provides communication links for passengers to call the taxi, and allows taxi passengers to use the free shuttle buses to access the terminals from the dock. Water taxi information is posted on the Massport website. Details on water taxi services are provided in Chapter 5, *Ground Access to and from Logan Airport*.
Other Measures	
Coordinate with public and private entities to provide more extensive radio, television, and telephone announcements of poor traffic conditions with suggestions for alternative access modes.	**Implemented.** Callers to the Customer Information Line (1-800-23LOGAN) may access the latest traffic information, flight status, parking information, cell phone waiting lot information, or learn about alternative forms of transportation to and from Logan Airport. Starting in August 1999, real-time traffic information and parking became accessible on Massport's website. Massport regularly contacts the media to inform the public about roadway changes, parking shortages, and to encourage travelers to use HOV services. Similar information is disseminated on the Logan Airport e-mail subscriber list, the Massport website, Facebook, and on Twitter at twitter.com/bostonlogan.

**Table 9-1 West Garage Project Status Report (EEA #9790)
Details of Ongoing Section 61 Mitigation Measures (as of December 31, 2018) (Continued)**

Mitigation Measure	Status
HOV Marketing and advertising. Massport will continue the advertising and marketing programs for HOV services with an emphasis on promoting MBTA, Logan Express and water shuttle services to and from the Airport.	**Implemented.** Massport continues to market Logan Express services via Massport's website and other media. Massport continues to promote HOV services including availability, schedules, and fares to consumers through the Customer Information Line at 1-800-23LOGAN and the website, which provide up-to-the-minute information. HOV advertising boards, schedules, and maps are placed at all Logan Airport terminals, at the MBTA Blue Line Airport Station, and at all shuttle bus drop-off/pick-up locations. Massport has actively promoted passenger water transportation in Boston Harbor for more than 20 years, playing a leadership role in policy development, planning, and promotions. This has included promoting vessel services at Logan Airport in the following ways: ▪ Annual updates and in-terminal distribution of a brochure promoting water transportation at Logan Airport; ▪ Annual updates of a harbor-wide water transportation map showing routes serving Logan Airport along with other routes and landings – Massport provides this map to the MBTA, area non-profits, and others interested in promoting passenger water transportation in Boston Harbor; ▪ Updated information promoting passenger water transportation at Logan Airport on 1-800-23LOGAN and www.massport.com; and ▪ Collecting, tracking, and disseminating passenger water transportation ridership data for Logan Airport passengers to aid in planning and facility development.
Prepare an inventory of private scheduled services including origins/destinations, schedule, and cost.	**Implemented.** Massport continues to update and track information and services by hundreds of privately operated passenger services certified to operate at Logan Airport. Industry changes with such operations make publication of reliable service and schedule information impractical, if not impossible. However, Massport continued to expand and update information on transportation options to Logan Airport using: ▪ Information and links to transportation companies on the Massport website. Some sites accessed through internet links provided passengers with online reservation services. ▪ Most scheduled service operators provided placards with current schedules posted in bus stop shelters located on the curb at each terminal. Individual bus schedules were also available at the information booths. Transportation information database for online assistance at Logan Airport terminal information booths.

Table 9-1 West Garage Project Status Report (EEA #9790)
Details of Ongoing Section 61 Mitigation Measures (as of December 31, 2018) (Continued)

Mitigation Measure	Status
Proceed with environmental review and seek funding for construction of People Mover system.	**Implemented.** Massport completed the Environmental Assessment (EA) and Major Investment Study for the Logan Airport Intermodal Transit Connector (AITC). The AITC evolved out of the People Mover process and evaluated new access routes to both the MBTA Blue Line and the South Station Transportation Center. On February 25, 1997, Massport submitted to the U.S. House Committee on Transportation and Infrastructure an application for Intermodal Surface Transportation Efficiency Act of 1991 (ISTEA) funds for the next phase of environmental review, planning, and design of the AITC. Congressman J. Joseph Moakley was the congressional sponsor; the project also had the support from the Secretary of Transportation and the U.S. Environmental Protection Agency (EPA). The Logan AITC was included, for an unspecified funding level, in the 1997 ISTEA reauthorization bill. In 1998, Massport received a Certificate on a Notice of Project Change (NPC) for the People Mover from the Secretary of the Executive Office of Energy and Environmental Affairs (EEA) and a Finding of No Significant Impact (FONSI) on an Environmental Assessment (EA) from the Federal Transit Authority. In June 2001, Massport and the MBTA executed an interagency agreement for the purchase of eight Silver Line dual mode buses and the Massport Board approved the expenditure of approximately $13 million for this purchase. In 2004, Massport and the MBTA finalized the 10-year/20 million-dollar Interagency Operating & Maintenance Agreement. Initial Silver Line service to the Airport began in December 2004 and full service began in June 2005. Services continue to be adjusted to meet growing demand as described in *Chapter 5, Ground Access to and from Logan Airport*. Several options are being considered to reduce on-Airport congestion and improve on-Airport ground access efficiency, including dedicated HOV bus lanes, the creation of an intermodal transportation center with bus service to terminals, the construction of an Automated People Mover (APM), or some combination of these improvements (see Chapter 3, *Airport Planning,* for more information).
Alternative Fuels Program. Massport is carrying out an extensive program to convert existing Massport-owned service vehicles to environmentally preferable sources.	**Implemented. Table 9-2** of this *2017 ESPR* details Massport's progress in achieving these measures.
Massport will assess progress towards the achievement of HOV goals using on-Airport Automated Traffic Monitoring Systems (ATMS).	**Implemented.** Massport has an ATMS plan that provides daily traffic counts at all gateways and other critical locations. Massport uses technologies that utilize on-Airport traffic signal controllers and loops for traffic counting. The Logan Airport ATMS uses technologies that detect vehicle movement (inductive loop lines and microwave sensors). The project is complete and the upgraded ATMS is functioning as planned and designed.
Massport will assess progress towards the achievement of HOV goals by monitoring parked vehicles using systems such as the parking and revenue control (PARC) system.	**Implemented.** Massport monitors all parking activity at Logan Airport and inventories all commercial parking facilities on a daily basis. Updated PARC systems were installed in the Terminal B Garage in 2004, with the Central/West Garage following in 2005. Terminal E parking areas and the Economy Garage also have PARC systems, as will the planned new parking areas.

Table 9-1 West Garage Project Status Report (EEA #9790)
Details of Ongoing Section 61 Mitigation Measures (as of December 31, 2018) (Continued)

Mitigation Measure	Status
Measuring, Monitoring, and Evaluating Ground Access Improvements	
Monitor HOV Services (Logan Express, MBTA, water shuttle, limousine/bus, and taxi).	**Implemented.** Massport maintains a "real time" log of dispatcher reports for Logan Express, the taxi pool, and the bus/limousine pool and other ground transportation operations at Logan Airport. Massport coordinates with the MBTA and the operators of all water shuttles serving Logan Airport to track ridership and service schedules. Daily Logan Express ridership and operations data are submitted monthly to Massport. Massport maintains a Passenger Water Transportation Ridership Summary on a monthly basis. Massport maintains a continuing record, the Ground Transportation Unit (GTU) Daily Event Log, of all occurrences impacting the Airport roadways, terminal curbs, and access roads. This log cites such events as accidents, lane closures, bus delays, as well as routine and non-transportation events. Massport's Ground Transportation Operations Center (GTOC) located in the Rental Car Center (RCC) is the 24/7 command center for all transportation information in and around Logan Airport. GTOC staff monitor up to the minute traffic information to ensure Logan Airport bus services are running efficiently.
Monitor passenger activity and employee modes of transportation.	**Implemented.** The 2016 air passenger survey was conducted in the spring of 2016 and was summarized in Chapter 5, *Ground Access to and from Logan Airport,* of the *2016 EDR*. The results of the 2019 air passenger survey will be presented in the next EDR.
Massport supports the use of Automated Vehicle Identification (AVI) to monitor, manage, and facilitate efficient traffic operations at Logan Airport and elsewhere on the regional transportation system.	**Implemented.** An AVI system for Massport's Logan Airport shuttles and Logan Express buses was implemented. All new buses are being procured with AVI/global positioning system (GPS), and are compatible with the "next bus" arrival notification system. In addition, the GTOC in the new RCC is outfitted with the required equipment to track the clean-fuel unified bus fleet.
Track the effectiveness of ground access measures.	**Implemented.** Massport continues to track the effectiveness of its ground access mitigation programs in its annual Massachusetts Environmental Policy Act (MEPA) filings. See Chapter 5, *Ground Access to and from Logan Airport,* for 2017 details.

Source: Massport.
Note: Text in *italics* detailing the mitigation measures is from Section IV, Mitigation of the West Garage Final EIR, January 31, 1995.

Table 9-2 describes the Alternative Fuels Program, which was part of the West Garage Section 61 commitments.

Table 9-2 Alternative Fuels Program — Details of Ongoing Section 61 Mitigation Measures for the West Garage Project (as of December 31, 2018)

Program Element	Projected Date of Completion/ Acquisition	Status
Purchase four electric passenger utility vehicles	Winter 1995	**Implemented.**
Purchase five electric sedans	Winter and Summer 1995	**Implemented.**
Build compressed natural gas (CNG) quick-fill station	Spring 1995	**Implemented.** The CNG station has been operational since 1995. It is one of New England's largest retail CNG quick fill stations and serves approximately 34 Massport CNG vehicles (22 of which are the Massport-owned 42-foot CNG buses) along with a dozen Airport tenants including nearby hotel CNG shuttle bus fleets. In 2017, the station dispensed approximately 25,200 gasoline-equivalent gallons per month for Massport vehicles.
Purchase five electric buses	Spring and Summer 1995	**Implemented.** Massport purchased two electric buses and leased one. These vehicles operated at Logan Airport between 1996 and 2001. After more than six years of testing and evaluation, Massport determined that electric buses are neither durable nor dependable enough to function effectively in the demanding operating environment at Logan Airport. Massport's new unified bus fleet includes clean diesel/electric hybrid buses. Massport continues to evaluate electric and other alternative fuel vehicles (AFV) as new technologies become available. Massport supports the use of AFV by replacing older fleet vehicles with alternative fuel fleet vehicles and continues operation of Massport's "Clean-Air-Cab" incentive program for AFVs. Massport encourages conversion to AFVs/alternative power vehicles (APVs) by others through such policies as 50 percent discounts in AFV/APV ground access fees to limousines, vans, and buses; limited "front-of-line" taxi pool privileges to hybrid and AFVs/APVs; and preferred parking for hybrid and AFVs/APVs at Logan Airport parking facilities. As part of the ongoing Alternative Fuel Program, Massport is facilitating the replacement of gas- and diesel-powered ground service equipment (GSE) with all-electric GSE (eGSE) by the end of 2027, as commercially available. The U.S. Environmental Protection Agency (EPA) awarded a $541,817 grant in 2018 to Massport to replace some gas- and diesel-powered GSE at Logan Airport in a collaborative effort to reduce emissions and improve air quality. Massport contributed a $622,221 match. This grant will allow Massport to replace 25 pieces of gas- and diesel-powered GSE with all-electric versions. This grant will be used in conjunction with a Federal Aviation Administration (FAA) grant Massport received in the fall of 2018 to install eGSE charging stations for the Terminal B Optimization Project.
Purchase five electric pick-up trucks	Spring 1995	**Implemented.**

Table 9-2 Alternative Fuels Program — Details of Ongoing Section 61 Mitigation Measures for the West Garage Project (as of December 31, 2018) (Continued)

Program Element	Projected Date of Completion/Acquisition	Status
Use soy-blend diesel fuel	Spring 1995	**Implemented.** Massport's shuttle fleet operated on soy diesel from 1995 to 1999. In 1999, all the buses were replaced with CNG buses. This fleet was fully replaced in 2012 by CNG and clean-diesel/electric hybrid buses.
Purchase additional AFVs	Spring 1995	**Implemented.** Refer to Chapter 7, *Air Quality/Emission Reductions,* for a list of AFVs.
Purchase six CNG buses	Summer 1995	**Implemented.** The initial fleet of 26 CNG shuttle buses was fully replaced in 2012 with 32 60-foot clean diesel/electric hybrid buses and 18 42-foot CNG buses. Three CNG buses were added to the fleet in 2015, increasing the total from 18 to 21; and one additional CNG bus was added in 2016, increasing the total from 21 to 22.
Purchase four electric vans	Summer 1995	**Implemented.**
Install quick-charge kiosks for electric vehicles	Summer 1995	**Implemented but no longer in use.** Massport provides 173 hybrid, electric, and AFV only on-Airport parking spaces spread out among the Terminal and Economy Garage parking locations. Twenty-six of these spaces provide electric charging spaces convenient to the terminals. Massport has committed to increasing the availability of EV charging stations so that 150 percent of demand is available at all facilities at all times.
Develop slow-charge infrastructure	Ongoing	**Implemented.** The electric charging infrastructure included 15 inductive charging locations. Currently, these are not in use because there are no vehicles using inductive charging. In 2012, Massport installed 13 Level 2 electric vehicle (EV) charging stations to accommodate a total of 26 vehicles in the Central Garage and Terminal B parking areas. The Framingham Logan Express Garage also has two EV charging stations. Massport plans to add EV charging infrastructure to all new parking facilities. Massport has committed to increasing the availability of EV charging stations so that 150 percent of demand is available at all facilities at all times.

Source: Massport.

International Gateway Project (Terminal E) – EEA #9791

Permitting History:

- Certificate on the Final EIR issued on December 2, 1996.
- Section 61 Findings submitted to EEA on June 26, 1997.

Project Status

The International Gateway Project (**Figure 9-2**) expanded and upgraded Terminal E to provide better service to international passengers. The original Terminal E was opened in 1974 and over time became outdated and too small to accommodate the growth in international travel. This project is being constructed in phases:

- **Phase I – Complete.** This phase included a weather-protected outside airside bus portico with an elevator and escalator linking the ground floor to the second floor to accommodate passengers arriving on remotely parked aircraft (that are unable to park at a gate because it is occupied by another aircraft).
- **Phase II – Complete.** This phase enlarged Logan Airport's congested Federal Inspection Services (FIS) Facility and improved the meeter/greeter lobby and the ticketing area of Terminal E to maximize passenger convenience and reduce processing times in the terminal. The project called for the reconstruction and expansion of Terminal E in and around the existing terminal while keeping it operational and safe. The new departure hall includes high ceilings, wood paneling, built-in artwork, and views of the city skyline. Additionally, to reduce curb and roadway congestion at Terminal E, this project included a new separated roadway system for arrivals and departures.
- **Future Phase – Transitioned to Terminal E Modernization Project (EEA #15434).** The West Concourse element of the International Gateway Project and its three additional gates were approved but not constructed. These three gates are now included in the Terminal E Modernization Project.

Construction of Phases I and II of this project commenced in the summer of 1998. Phase I was completed in 2004. The departure level of the terminal, including the new ticketing hall and departure level roadway, opened in May 2003. Enlargement of the FIS Facility and construction of the new arrivals level was completed in July 2007. Phase II is now complete. Preliminary work was completed for the West Concourse including planning for three additional contact gates that were not constructed. Additional information on the status of this project is available in Chapter 3, *Airport Planning.*

As part of a separate project, Massport has approval for the modernization of Terminal E. The Terminal E Modernization Project will accommodate existing and forecasted long-range passenger demand for international service and will include the three permitted but not built gates from the West Concourse component of the International Gateway Project, as well as four additional new aircraft contact gates. An ENF was filed in October 2015. The Draft EIR/EA was filed in July 2016, and the Final EA/EIR was filed in September 2016. The FAA issued a FONSI on November 10, 2016, and a ROD on November 14, 2016 for the project (see Chapter 3*, Airport Planning,* for additional information). Final design is underway and initial construction began in 2019.

Table 9-3 lists each of the continuing mitigation measures for the International Gateway Project in the Section 61 Findings, along with Massport's progress in achieving these measures through the end of 2017. Many of the mitigation measures for this project have long since been implemented, but it is noted in the tables when there have been recent updates. Completed design and construction phase measures are described in previous EDRs.

FIGURE 9-2 International Gateway Project

2017 Environmental Status and Planning Report

Note: Runway 14-32 construction completed in November 2006.

◆ International Gateway Project (Terminal E) - EEA #9791

0 500 1000 2000 Feet

Table 9-3 International Gateway Project Status Report (EEA #9791)
Details of Ongoing Section 61 Mitigation Measures (as of December 31, 2018)

Mitigation Measure	Status
Alternative Fuel Outreach Program	
Massport is working cooperatively with the U.S. Environmental Protection Agency (EPA) and regional utility providers in coordinating an ongoing outreach program aimed at promoting the use of clean-burning alternative fuels. This program, which is also supported by fuel providers, vendors, and state and federal agencies, will offer information to airport tenants in the following areas: ▪ *Notification of grant programs or other financial incentives for vehicle conversions.* ▪ *Assistance in cost-benefit analysis for conversion of conventionally fueled vehicles to Alternative Fuel Vehicles (AFVs).* ▪ *Assistance in placing airport tenants in contact with alternative fuel suppliers and product vendors.*	**Implemented but no longer in use.**
High Occupancy Vehicle (HOV) Promotion	
Massport will reserve terminal space for ground transportation ticket sales, reservations, and information.	**Implemented.** In a joint venture with the Massachusetts Bay Transportation Authority (MBTA), Charlie Card automated fare collection equipment was installed in all Logan Airport terminals in 2006. Since mid-2012, in an effort to encourage greater transit ridership, Massport continues to offer free boarding of the Silver Line at Logan Airport. Free Silver Line boarding continued throughout 2016. Additional ground transportation information is provided om Massport's website at http://www.massport.com/logan-airport/to-from-logan/transportation-options/.
Attractive and distinctive signage and graphics will be utilized inside the terminal and out at the curb to clearly mark access to Logan Express, MBTA, water transportation, and other HOV options.	**Implemented.** Signage is installed in the terminal and at the curbside identifying HOV curb locations. In 2012, Massport installed new digital signage at all terminal Silver Line curb locations to indicate next bus wait times, which has improved passenger convenience.
As HOV services continue to develop and expand at Terminal E, Massport will expand its web page to encompass these new services and initiatives.	**Implemented.** Massport continues to reflect service changes on its website.
Massport and the MBTA will offer, on a trial basis, the sale of MBTA tokens via a vending machine in the baggage claim area of Terminal C.	**Implemented.** The MBTA Charlie Card machines are located at the MBTA's Blue Line Airport Station and in each of the Logan Airport passenger terminals. Massport continues to offer free service to Airport Station and the water shuttle dock with its fleet of compressed natural gas (CNG) and clean diesel/electric hybrid buses. Since the summer of 2012, Massport continues to sponsor free rides on the Silver Line from Logan Airport to downtown Boston.

Source: Massport.
Note: Text in *italics* detailing the mitigation measures is excerpted from the Section 61 Findings submitted to the EEA, June 26, 1997.

Replacement Terminal A Project – EEA #12096

Permitting History

- Certificate on the Final EIR issued on November 16, 2000.
- Section 61 Findings submitted to EEA on August 31, 2001.

Project Status

The Replacement Terminal A Project (**Figure 9-3**) replaced the original Terminal A with a main terminal linked to a satellite concourse. The new Terminal A opened on March 16, 2005.

In the spring of 2006, Delta Air Lines and Massport submitted an application for certification of Terminal A under the U.S. Green Building Council's (USGBC) Leadership in Energy and Environmental Design (LEED®) Green Building Rating System™. LEED certification was awarded in June 2006, making Terminal A the first airport terminal in the world to be awarded LEED certification.

The following sustainable elements were incorporated into the design of Terminal A:

- **Water conservation** – low-flow toilets and drip, rather than spray, irrigation.
- **Atmosphere protection** – zero use of chlorofluorocarbon-based, hydrochlorofluorocarbon-based, or halon refrigerants.
- **Energy conservation** – special roofing and paving materials that reflect solar radiation. Solar panels were installed on the roof of Terminal A in 2012.
- **Materials and resources conservation** – more than 10 percent of all the building materials used to construct the terminal were from recycled materials.
- **Enhanced indoor environmental air quality** – low and volatile organic compound (VOC) free adhesives, sealants, paints, and carpets were used.
- **Sustainable sites** – bicycle racks were installed.

Table 9-4 lists each mitigation measure in the Section 61 Findings along with Massport's progress in achieving these measures through the end of 2017.

FIGURE 9-3 Replacement Terminal A Project

2017 Environmental Status and Planning Report

◆ Terminal A Replacement Project - EEA #12096

0 450 900 1800 Feet

Table 9-4 Replacement Terminal A Project Status Report (EEA #12096)
Details of Ongoing Section 61 Mitigation Measures (as of December 31, 2018)

Mitigation Measure	Status
Project Design Mitigation	
Logan Transportation Management Association (TMA) Participation	
Delta Air Lines, Inc. to join Massport's Logan TMA and designate an Employee Transportation Advisor.	**Implemented.** Delta Air Lines joined the Logan TMA and designated an Employee Transportation Advisor.
Additionally, Delta Air Lines will provide the following services as part of their Transportation Demand Management Program through the Logan TMA Transportation subsidy for full-time Delta Air Lines employees at Logan Airport; ride matching/carpooling; vanpooling; guaranteed ride home; preferential parking for high occupancy vehicles (HOVs); shuttle to and from employee parking.	**Implemented.** Transportation Demand Management (TDM) services are provided through Delta Air Lines and the Logan TMA.
Recycling Program	
The Replacement Terminal A will be included in Massport's terminal recycling program.	**Implemented.** Paper, plastic, aluminum, glass, and cardboard are recycled at Terminal A. In 2013, Massport converted to single-stream recycling in all terminals. Massport established aggressive recycling goals as part of its 2015 Logan Airport Sustainability Management Plan (SMP) and is actively working to reduce waste and increase its recycling rate. As part of this effort, Massport installed liquid diversion stations at the security checkpoint for Terminals A, B, C, and E in the spring of 2016. Passengers are now able to empty their bottles before security and re-fill them again on the secure side for the remainder of their journey.
High Occupancy Vehicle (HOV) Promotion	
HOV access can be accommodated on the departures level and will be designated near main entrances to the terminal building to ensure efficient and convenient unloading by air passengers who use these mode-types to access the Airport. *The inner-most curb of [the arrivals level] will be designated exclusively for HOVs and taxis, similar to the departures level.*	**Implemented.** Curbside HOV lanes give HOV modes preferential access to Terminal A for passenger convenience at both the arrival and departure levels. Coinciding with the opening of the Rental Car Center (RCC) (and its new on-Airport shuttle bus operations), in September 2013, Massport made improvements to the terminal curbsides to increase access for HOV, transit, and shared-ride modes. The improvements followed several general principles: situate HOV modes to the curb closest to the terminal and locate the Airport's Blue Line/RCC shuttle stop adjacent to the Silver Line stop. Terminals B, C, and E underwent the most significant changes; in fact, the ground level of the Terminal B garage was converted to a taxi and limousine (and subsequently the Transportation Network Company [TNC]) pick-up area, eliminating all commercial parking from that level, and allowing extra curb space to be better allocated among the remaining HOV and other modes. Terminal A, which already had the primary HOV modes pick-up at the terminal curb (and private vehicles pick-up at the second/outer curb), underwent the fewest changes (notably relocating the Silver Line bus stop to be adjacent to the Blue Line/RCC shuttle stop). The curb improvements also included adding electronic "next bus arrival time" displays for the Massport shuttles, Massachusetts Bay Transportation Authority (MBTA) Silver Line, and Logan Express buses.

Table 9-4 Replacement Terminal A Project Status Report (EEA #12096)
Details of Ongoing Section 61 Mitigation Measures (as of December 31, 2018) (Continued)

Mitigation Measure	Status
Ground Service Equipment (GSE) Conversion	
In conjunction with the Project, Delta Air Lines will implement a program for conversion of its entire GSE fleet at Terminal A as soon as viable alternative fueled fleet vehicles become available and can be effectively integrated into Delta Air Lines' operations at Terminal A. Delta Air Lines will introduce battery powered baggage tugs and belt loaders with the replacement terminal and convert this portion of the GSE fleet by the end of 2008. This represents over 40 percent of Delta Air Lines' current GSE fleet.	**Implemented.** Terminal A incorporates infrastructure for GSE charging. In September 2009, Massport approved a 3-million-dollar loan to Delta Air Lines for the purchase of battery-powered baggage tugs and battery powered-baggage conveyor belt vehicles. Delta Air Lines purchased 50 electric baggage cart tugs, 25 electric baggage conveyor belt vehicles, and charging stations for each vehicle. Thirty-two GSE chargers are currently serving electric GSE. Massport is facilitating the replacement of gas- and diesel-powered GSE with all-electric GSE (eGSE) by the end of 2027, as commercially available.
Delta Air Lines will also examine the feasibility of locating a Compressed Natural Gas (CNG) fill station at Terminal A. The availability of a CNG fueling station would facilitate conventionally-fueled vehicles to be replaced with CNG-fueled vehicles where this vehicle option is offered. Delta Air Lines will introduce these vehicles into its GSE fleet as soon as they become available and are determined to be feasible and practicable for use at Terminal A.	**Implemented.** Delta Air Lines examined the feasibility of locating the CNG fill station at Terminal A and determined it to be infeasible, given that the GSE conversions are trending toward electric vehicles and electric vehicle infrastructure. A public access CNG fuel facility is available on the Airport at 81 North Service Road. Massport is facilitating the replacement of gas- and diesel-powered GSE with eGSE by the end of 2027, as commercially available.
Where new alternative fuel vehicles (AFVs) are developed and determined to be cost effective and in available supplies, Delta Air Lines will integrate their use into its Terminal A GSE fleet operations.	**Implemented.** As described earlier, Delta Air Lines has electric baggage tugs and belt loaders and will continue to determine the feasibility of integrating other alternative fuel GSE, as available. Massport is facilitating the replacement of gas- and diesel-powered GSE with eGSE by the end of 2027, as commercially available.
Finally, Delta Air Lines will provide Massport with an annual status report/update on the GSE conversion program at Terminal A, for inclusion in Massport's annual Environmental Data Report (EDR).	**Implemented.** Terminal A includes 32 electric charging stations for Delta Air Lines' electric ramp vehicles. As part of an Airport-wide initiative, Massport is facilitating the replacement of gas- and diesel-powered GSE with eGSE by the end of 2027, as commercially available.
Operational Mitigation Measures	
Minimizing nighttime movement of aircraft to and from hardstand positions.	**Implemented.** In accordance with the Noise Rules, Massport continues to restrict nighttime movement of aircraft under its own power between 10:00 PM and 7:00 AM, and Massport also requires towing during this time period.

Table 9-4 Replacement Terminal A Project Status Report (EEA #12096)
Details of Ongoing Section 61 Mitigation Measures (as of December 31, 2018) (Continued)

Mitigation Measure	Status
Using single engine taxiing and pushback to the extent feasible and practicable, recognizing that such use is always at the discretion of the pilot in charge of the aircraft based upon his or her experience and safety and operational considerations.	**Implemented.** Massport has conducted two surveys of Logan Airport air carriers (2006 and 2009) to understand the extent single engine taxiing is used at Logan Airport. Massport annually issues letters to air carriers in support of single engine taxiing when consistent with safety procedures. Massport is an active member of the Federal Aviation Administration (FAA) Partnership for Air Transportation Noise and Emissions Reduction (PARTNER) program on reducing noise and emissions. In 2009, Massport offered to facilitate the undertaking by the Massachusetts Institute of Technology (MIT) of a more detailed survey of pilots at Logan Airport to better understand the use of single engine taxiing. MIT completed its survey and issued a paper in March 2010 (as provided in the *2010 EDR*). The MIT survey confirms earlier Massport survey findings that single engine taxiing is an important operational measure used by airlines to conserve fuel and is extensively used at Logan Airport. Based on the more detailed survey results, Massport will tailor future communication to airlines to further encourage the use of single engine taxiing, when safe to do so, within the Logan Airport operational context. In 2017, 2018, and 2019, Massport sent letters to the Boston airline community and the Logan Airport user community encouraging them to consider the use of single engine taxiing when safe to do so. This is provided in Appendix L, *Reduced/Single Engine Taxiing at Logan Airport Memoranda,* of this *2017 ESPR*.
Testing alternative de-icing methods to reduce the amount of glycol usage.	**Ongoing.** Delta Air Lines participated in the *Logan Deicer Management Feasibility Study* to evaluate alternatives to reduce discharges to Boston Harbor. The study report was submitted to the U.S. Environmental Protection Agency (EPA) in May 2017.

Source: Massport.
Note: Text in *italics* detailing the mitigation measures is excerpted from the Section 61 Findings submitted to the EEA, August 31, 2001.

Logan Airside Improvements Planning Project – EEA #10458

Permitting History

- Certificate on the Final EIR issued on June 15, 2001.
- Section 61 Findings, dated June 8, 2001, on the Final EIR.
- In June 2002, FAA filed a Final Environmental Impact Statement (Final EIS) and issued the ROD in August 2002 approving a unidirectional runway and other improvements, but deferred a decision on the centerfield taxiway pending additional review by FAA.
- In November 2003, the Superior Court of the Commonwealth modified a 1976 injunction prohibiting construction of a new runway at Logan Airport, pending further environmental review. The injunction modification allowed construction of the runway in accordance with the Secretary of EEA's Certificate on the Final EIR and FAA's ROD on the Final EIS.
- In accordance with the Secretary of EEA's Certificate on the Final EIR, Massport amended its final Section 61 Findings issued in 2001 to incorporate mitigation measures added or refined through the federal environmental review process. As a result, Massport amended its initial Section 61 Findings on October 21, 2004, to include mitigation measures required in FAA's ROD.
- In April 2007, FAA issued a ROD on the centerfield taxiway improvements based on its review of supplemental information.

Project Status

- Project construction commenced in 2004. Runway 14-32 opened on November 23, 2006. The first full year of operation of Runway 14-32 was 2007.
- Realignment of the southwest corner taxiway system was completed in 2007.
- Taxiway D extension was completed in 2010.
- Taxiway N realignment remains under consideration.
- Reduction in approach minimums on Runway 15R and 33L were implemented in 2013 following completion of the 33L Light Pier replacement and FAA testing of new Instrument Landing System (ILS) equipment.

The Logan Airside Improvements Planning Project (**Figure 9-4**) involved the construction of a new unidirectional Runway 14-32 and centerfield taxiway, extension of Taxiway D, realignment of Taxiway N, improvements to the southwest corner taxiway system, and reduction in approach minimums on Runways 22L, 27, 15R, and 33L. Reduction in approach minimums on Runway 15R and 33L were approved in the EIS. However, implementation for approach minimum reductions depended upon realignment of the ILS. The construction impacts of relocating the ILS localizer and new Category III ILS equipment were addressed in the environmental review of the RSA enhancements for Runway 33L (EOEA #14442). The Category III ILS began operations in 2013.

Table 9-5 summarizes the mitigation measures contained in the amended Section 61 Findings issued on October 21, 2004 and reports on the status of implementation. **Table 9-5** addresses only ongoing requirements, and it is noted when there are recent updates. Documentation on design and construction measures is provided in previous EDRs.

FIGURE 9-4 Logan Airside Improvements

2017 Environmental Status and Planning Report

Note: Runway 14-32 construction completed in November 2006

◆ Improved Taxiways

● Reductions in Approach Minimums

Table 9-5 Logan Airside Improvements Planning Project (EEA #10458)
Details of Ongoing Section 61 Mitigation Measures (as of December 31, 2018)

Mitigation Measures	Status
Runway 14-32 Operations and Construction Mitigation	
Operational procedures for unidirectional Runway 14-32 will include over-water flight operations only, arrival operations in east-to-west direction from Runway 32 approach end, and departure operations from west-to-east direction from the Runway 14 departure end. Massport will enter into contract with appropriate government body and/or community group(s) to enforce intended unidirectional runway, if requested. Lighting, marking, and instrumental components of Runway 14-32 will be designed for a unidirectional runway. No parallel or other type taxiway facility will be constructed to allow east-to-west direction departures from the Runway 32 end. *The Federal Aviation Administration (FAA) endorsed the unidirectional limitations on Runway 14-32 and has agreed to develop air traffic control procedures to ensure safe and efficient operation of the unidirectional limitation, subject to variances that may be required to accommodate particular aircraft emergencies.*	**Implemented.** Runway 14-32 was constructed for unidirectional operation. All lighting, marking, and navigational instrumentation was constructed and is operated for unidirectional use only. There is no parallel or other type of taxiway facility that would facilitate east-to-west direction departures from the Runway 32 end. The construction mitigation measures were incorporated into the final design specifications and were implemented during construction. Runway 14-32 opened on November 23, 2006.
Wind-Restricted Use of Runway 14-32	
Restrict the use of Runway 14-32 to those times when winds are equal to or greater than 10 knots from the northwest or southeast (between 275 degrees and 005 degrees, or 095 degrees and 185 degrees, respectively).	**Implemented.** Massport provided initial data to support the FAA's effort. FAA implements the wind restriction in compliance with the federal Record of Decision (ROD).
Mitigation Policies/Programs	
Regional Transportation Policy	
Engage in promoting increased utilization of regional airports. *Cooperative transportation planning with the various transportation agencies to ensure an integrated regional transportation infrastructure (i.e., improved highways, public transportation, high-speed rail, private transportation services to improve regional airport access).*	**Implemented.** Please refer to Chapter 4, *Regional Transportation*, for updated information on regional transportation efforts.
Massport will continue to exercise operational control over Worcester Regional Airport.	**Implemented**. Massport exercised operational control over Worcester Regional Airport as part of its agreement with the City of Worcester, which went into effect on January 15, 2000. In April 2004, Massport and the City of Worcester agreed to a three-year extension of the Operating Agreement, extending Massport's operation of Worcester Regional Airport through June 2007. Subsequently, both parties agreed to a further extension. Legislation was passed in 2009 requiring Massport to assume ownership of Worcester Regional Airport. Massport's ownership of Worcester Regional Airport commenced on July 1, 2010.

Table 9-5 Logan Airside Improvements Planning Project (EEA #10458)
Details of Ongoing Section 61 Mitigation Measures (as of December 31, 2018) (Continued)

Mitigation Measure	Status
Massport will continue to attract new air service to Worcester Regional Airport.	**Implemented.** Massport continues to work with carriers and make other facility improvements to develop and sustain commercial service from Worcester. Massport is investing $100 million over the next 10 years to revitalize and grow commercial operations at Worcester Regional Airport. As a result of this collaboration, jetBlue Airways has already handled over 600,000 passengers at Worcester Regional Airport since commencing operations in late 2013, serving two Florida destinations. Starting in May 2018, jetBlue Airways offers flights to John F. Kennedy International Airport in New York, New York. American Airlines began offering flights to Philadelphia International Airport starting October 2018. Delta Air Lines plans to commence service between Worcester and Detroit in the summer of 2019.
Traveler and air service awareness will be provided to Worcester Regional Airport via marketing campaigns.	**Implemented.** Massport continues to aggressively market the Airport to potential commercial air service carriers. Massport worked with jetBlue Airways to begin service out of Worcester Regional Airport in November 2013. jetBlue Airways currently serves two Florida destinations from Worcester. jetBlue Airways recently commenced service between Worcester Regional Airport and John F. Kennedy International Airport in 2018.
Develop and maintain an aviation information database to include: aviation trend tracking reports for distribution to interested parties; statistical summaries of passenger levels, aircraft operations and airline schedule data at major New England regional airports; include a summary of regional airport trends and service developments in an Annual Report.	**Implemented.** Massport collects regional airport data. A summary of individual airport activity is published annually in the Environmental Data Reports (EDRs) and Environmental Status and Planning Reports (ESPRs).
Participate in other regional/state aviation forums.	**Implemented.** Please refer to Chapter 4, *Regional Transportation*, for updated information on regional transportation efforts.
Continue to work with FAA/regional airport directors to complete a New England Airports System Study to evaluate regional airports performance. FAA committed to work with other participants in the preparation of the study.	**Implemented.** The NERASP study was published in October 2006.

Table 9-5 Logan Airside Improvements Planning Project (EEA #10458)
Details of Ongoing Section 61 Mitigation Measures (as of December 31, 2018) (Continued)

Mitigation Measure	Status
Encourage transportation initiatives (i.e., commuter rail, rail or other links between regional airports) by relevant agencies or other governmental bodies through Transportation Bond Bill or other legislative initiatives to implement an improved effective regional transportation system.	**Implemented.** Massport continues to support regional transportation legislation and funding for other modes of transportation including the Massachusetts Bay Transportation Authority (MBTA) Silver Line and water transportation. Massport's support was instrumental in the opening of the Anderson Regional Transportation Center (RTC) in Woburn, which provides a station building for ticketing, baggage and passenger services, approximately 2,400 parking spaces for daily and overnight parking, loading platforms for Logan Express and local buses, improved access from Interstate 93 via a new interchange constructed and opened by the Massachusetts Department of Transportation (MassDOT, formerly the Massachusetts Highway Department), and a high-level platform commuter rail station.
Continue to support inter-city rail planning through the Boston Metropolitan Planning Organization (MPO).	**Implemented.** Massport continues to actively participate in the Boston MPO and contributes to the policy discussions in all modes of transportation.
Allow Massport's Logan Express satellite parking lots and stations available for third-party bus and park-and-ride connections to other regional airports, including Worcester, Manchester, and Providence.	**Implemented.** Upon request and review, Massport will continue to allow third party bus operators to provide service to regional airports from Logan Express facilities. In 2007, Massport enacted an agreement with Manchester-Boston Regional Airport to allow operation of a shuttle service between Manchester-Boston Regional Airport and the Anderson RTC in Woburn. That pilot program was replaced by hourly van service in 2008.
Sound Insulation	
Sound insulation is being provided within the Boston Logan Airside Improvements Planning Project Mitigation Contour including the affected residences of Chelsea, East Boston, Winthrop, and Revere. Through special project mitigations, FAA funding will be provided for residences with building code considerations to allow for the necessary upgrades thereby ensuring eligibility and participation in the sound insulation program. If FAA funding is unavailable to complete sound insulation to residences within the DNL 65 dB contour as a result of project implementation, Massport will provide the funding.	**Implemented.** Sound insulation was implemented in full compliance with state and federal regulatory requirements and mitigation commitments. Since 1986, Massport has sound insulated nearly 6,000 residential buildings, totaling over 11,515 dwelling units. See Chapter 6, *Noise Abatement,* for additional details on sound insulation.

Table 9-5 Logan Airside Improvements Planning Project (EEA #10458)
Details of Ongoing Section 61 Mitigation Measures (as of December 31, 2018) (Continued)

Mitigation Measure	Status
Preferential Runway Advisory System (PRAS)	
Massport will develop and implement a PRAS monitoring system and a new distribution system for reporting that will expand the contents of Massport's Quarterly Noise Reports and will involve the expansion of the distribution list to include the Logan Airport Citizens Advisory Committee (CAC). Runway utilization, dwell, and persistence reports will be included in the ESPR filings with the Massachusetts Environmental Policy Act (MEPA). Massport will continue to work with FAA to design additional reports to enhance the attainment of PRAS and Massport will begin to work with CAC to update PRAS. The current PRAS system will remain in place until superseded.	**Implemented.** Massport, the FAA, and the CAC initiated a noise study of Logan Airport. PRAS review and reporting was incorporated into the noise study. During Phase II of the ongoing Boston Logan Airport Noise Study (BLANS), the Logan Airport CAC voted to abandon PRAS because it had not achieved the intended noise abatement. Phase III of the BLANS focused on the development of an updated Runway Use Program. Operational tests of a new program began in November 2014 and continued through September 2016. The BLANS project ended in 2016 without the Logan Airport CAC agreeing on a new Runway Use Program. A final BLANS project report was issued in April 2017. For additional information, refer to Chapter 6, *Noise Abatement*. Runway utilization, dwell, and persistence reports continue to be included in the annual ESPR and EDR filings.
Noise Abatement Study	
FAA has committed to undertake a noise abatement study that will include enhancing existing or developing new noise abatement measures applicable to aircraft overflight impacts, which will take into account environmental benefit, operational impact, aviation safety and efficiency, and consistency with applicable legal requirements. The scope of this study has been completed through the joint efforts of FAA, the CAC, and Massport as required by the ROD. Massport will work with the CAC and FAA to assess the existing PRAS at Logan Airport in accordance with Section 10.0 of the Section 61 Findings and will continue to participate in the noise study as contemplated in the ROD.	**Implemented.** The FAA, in conjunction with Massport and the Logan Airport CAC, initiated the Boston Overflight Noise Study (BONS). Phase I of the study, completed in early 2007, defined and sought to implement changes to flight tracks to minimize impacts from aircraft overflights, which do not require a detailed Environmental Assessment (EA). Federal funding for Phase II was requested early to ensure seamless continuation of the study and transition. Phase II of the BLANS was completed in 2012. It addressed additional noise abatement alternatives that will require detailed analysis to meet FAA environmental requirements. Massport is working with the Logan Airport CAC and the FAA on Phase III of the BONS Study to design a runway use plan for the Airport. The Logan Airport CAC could not agree on a runway use program and Phase III was completed in August 2012. A final BLANS project report was issued in April 2017.
Peak Period Monitoring and Demand Management Program (DMP)	
Massport will develop and implement a Peak Period Pricing (PPP) program or an alternative DMP. Massport will identify standards to allow airlines to accurately predict scheduling costs and modify accordingly. Massport will establish and maintain a monitoring system. *Massport will comply with its commitments with respect to PPP or alternate DMP. FAA has indicated in the ROD that it stands ready to assist Massport in this endeavor.*	**Implemented.** In July 2004, Massport filed a proposed rule with the Office of the Massachusetts Secretary of State to formally initiate the state rulemaking process and public review to establish a peak period surcharge during designated peak delay periods at Logan Airport. The filing was followed by a public comment period that lasted through November 15, 2004. During the comment period, Massport conducted two public hearings. The Massport Board voted to establish the peak period surcharge program on January 16, 2005, and the program has been in place since then (see 740 CMR 27.03). Please refer to Appendix K, *Peak Period Pricing Monitoring Reports,* for additional details.

Table 9-5 Logan Airside Improvements Planning Project (EEA #10458)
Details of Ongoing Section 61 Mitigation Measures (as of December 31, 2018) (Continued)

Mitigation Measure	**Status**
Single Engine Taxi Procedures	
Develop and implement a program designed to maximize the use of single engine procedures by all tenant airlines, consistent with safety requirements, pilot judgment and federal law requirements.	**Implemented.** Massport supports the use of single engine taxiing when it can be done safely, voluntarily, and at the discretion of the pilot. Massport has conducted two surveys of Logan Airport air carriers (2006 and 2009) to understand the extent single engine taxiing is used at Logan Airport. Massport has also issued letters to air carriers in support of single engine taxiing when consistent with safety procedures. Massport is an active member of the FAA Partnership for Air Transportation Noise and Emissions Reduction (PARTNER) program on reducing noise and emissions. In 2009, Massport offered to facilitate the undertaking by the Massachusetts Institute of Technology (MIT) of a more detailed survey of pilots at Logan Airport to better understand the use of single engine taxiing. MIT completed its survey and issued a paper in March 2010 (as provided in the *2010 EDR*). The MIT survey confirms earlier Massport survey findings that single engine taxiing is an important operational measure used by airlines to conserve fuel and is extensively used at Logan Airport. In 2017, 2018, and 2019, Massport issued letters to air carriers in support of single engine taxiing when consistent with safety procedures. A copy of these letters is included in Appendix L, *Reduced/Single Engine Taxiing at Logan Airport Memoranda,* of this *2017 ESPR*.
Report on Progress of Logan Transportation Management Association (TMA)	**Implemented.** Chapter 5, *Ground Access to and from Logan Airport,* discusses the status of the Logan TMA and efforts to increase Logan TMA membership and overall high occupancy vehicle (HOV) access to Logan Airport. The focus is on expanding Logan TMA services, broadening HOV options, and supporting all major Logan Airport tenants to become members and actively participate in the Logan Transportation Demand Management (TDM) strategies. A local "Sunrise Shuttle" has been operating since 2007. New work includes: convening an interdepartmental working group focused on rideshare/employee commutes; increasing outreach to employees about transportation options; and hosting Employee Commute Fairs in 2017 and 2018.

Source: Massport.
Note: The mitigation measures in *italics* are those that were referenced in FAA's ROD and later incorporated into the Section 61 Findings amended on October 21, 2004.

Southwest Service Area (SWSA) Redevelopment Program, EEA #14137

Permitting History

- Certificate on the Final EIR issued on May 28, 2010.
- Section 61 Findings submitted to EEA on June 29, 2010.

Project Status

Massport continues redevelopment of the SWSA and completed the RCC in 2014. In addition to customer service benefits, consolidation of the rental car operations and their shuttle buses into one coordinated operation has resulted in reduced VMT and reduced air emissions. See Chapter 5, *Ground Access to and from Logan Airport*, for additional information on VMT reductions.

Construction of enabling projects commenced in late summer of 2010 and final design of the facility continued through 2011. All RCC facilities (the Garage Structure, Customer Service Center, permanent Quick Turnaround Areas (QTAs) 1 and 2, and temporary QTAs 3 and 4) would be constructed first. The first rental car companies moved into the QTA 1 in mid-2013 and the remaining companies by early 2014. By the end of 2015, the project was completed and fully operational. Logan Airport's new bus fleet, comprising 21 CNG buses and 32 clean diesel/electric buses, has fully replaced the entire fleet of diesel rental car shuttle buses now that the RCC is fully operational. An additional CNG bus was put into service in 2016, increasing the total to 22 CNG buses. Additionally, in keeping with its commitment to sustainability, Massport is proud that the RCC was awarded Logan Airport's first LEED Gold certification in 2015.

Table 9-6 outlines Section 61 mitigation commitments of the SWSA Redevelopment Program, which Massport, the construction contractors, and the rental car companies have implemented as part of the design, construction, and operation of the facility. This project is now complete, and there is updated progress for each mitigation measure.

**Table 9-6 Southwest Service Area (SWSA) Redevelopment Program (EEA #14137)
Details of Ongoing Section 61 Mitigation Measures (as of December 31, 2018)**

Mitigation Measure	Status
Site Design	
Stormwater Management	
Improve quality of runoff by upgrading stormwater management facilities site-wide, reducing the volume of flow to the Maverick Street Outfall by increasing pervious area site-wide, utilization of Low Impact Design elements, and replacing uncovered parking areas with buildings.	**Implemented.** These stormwater design features were included in the final project design and are part of the project. The stormwater features include 27 Stormceptors constructed as part of this project. Stormceptors are prefabricated, underground units that separate oils, grease, and sediment from stormwater runoff when installed as part of a pipe conveyance system.
Design new sanitary and drainage systems to result in an overall reduction in combined sewer overflow volumes at the Porter Street Outfall and eliminate discharge to Maverick Street Outfall and Bird Island Flats/West Outfall.	**Implemented.** The sanitary sewer system adds new connections at Gove Street and Harborside Drive. Sanitary flows to the Maverick Street sewer were significantly reduced once the connection was completed. The stormwater analysis showed an overall reduction in the post-development stormwater flows for the project, as well as reductions in flows to the Porter Street and West Outfalls and elimination of stormwater flow to the Maverick Street Combined Sewer. Both the sanitary sewer system and stormwater drainage system are completed.
Remediation and Underground Fuel Storage Systems	
Remove all existing car rental fueling systems and associated tanks and replace with current, state-of-the-art vehicle fueling and washing facilities.	**Implemented.** This element has been implemented as part of the Quick Turnaround Areas (QTA). Massport installed state-of-the-art car wash drying equipment in 2018 for seasonal operation to alleviate worker and customer safety issues associated with ice.
Noise Reduction Measures	
Eliminate individual rental car shuttle buses and combine Massport Airport Station buses (routes 22/33/55) through the Unified Bus System; thereby, reducing the overall number of rental car-related buses circulating on-Airport and associated noise.	**Implemented.** Massport purchased a new bus fleet which was put into operation in 2012. The new bus fleet, comprising 21 compressed natural gas (CNG) buses and 32 clean diesel/electric buses, has fully replaced the entire fleet of diesel rental car shuttle buses with the Rental Car Center (RCC) opening in 2013. One additional CNG bus was put into service in 2016, increasing the total from 21 to 22 buses.
Incorporate noise reduction strategies into site design, such as solid fences/walls, gateway signs/walls, and landscaped berms.	**Implemented.** All noise reduction measures were constructed. In 2017, at the request of the rental car companies, Massport evaluated installation of state-of-the-art vehicle drying systems that would eliminate safety issues arising from freezing at the end of the washing cycle. In the fall of 2018, Massport installed low-noise drying equipment in each of the four vehicle QTAs. The new equipment is operated primarily during daytime hours, seasonally when freezing conditions typically occur.

**Table 9-6 Southwest Service Area (SWSA) Redevelopment Program (EEA # 14137)
Details of Ongoing Section 61 Mitigation Measures (as of December 31, 2018) (Continued)**

Mitigation Measure	Status
Airport Transportation System Improvements	
Reduce the rental car shuttle bus fleet by approximately 70 percent through the creation of the Unified Bus System when compared to the 2007 Existing Condition and future No-Build/No-Action Conditions.	**Implemented.** Massport purchased a new Unified Bus Fleet of diesel/electric hybrid and CNG buses. The initial buses were put into operation in 2012. Full implementation of the new bus fleet occurred when the RCC opened in the fall of 2013.
Reduce rental car shuttle bus terminal curbside congestion through the creation of the Unified Bus System resulting in reduced emissions.	**Implemented** upon project opening. Massport purchased a new Unified Bus Fleet which was put into initial operation in 2012.
Utilize clean- and low-emission fuel for the Unified Bus System to further reduce emissions.	**Implemented** upon project opening. Massport has purchased a new Unified Bus Fleet. The new fleet is comprised of diesel/electric hybrid and CNG buses.
Install Intelligent Transportation System features, as part of the Unified Bus System to further reduce emissions and improve operational efficiency.	**Implemented** upon project opening. Massport purchased a new Unified Bus Fleet which was put into initial operation in 2012.
Implement new wayfinding signage to increase the efficiency of the circulating vehicles within and around the SWSA.	**Implemented** upon project opening.
Pedestrian and Bicycle Facilities	
Provide new pedestrian and bicycle facilities, including secure and covered bicycle storage at the Customer Service Center (CSC) and QTA buildings for employees, customers, and the general public, as well as shower/changing facilities within the QTA buildings for employees.	**Implemented.**
Provide enhanced pedestrian connections to and from the SWSA, airport terminals, the Logan Office Center, Memorial Stadium Park, Bremen Street Park, the Harborwalk, on-Airport buses, public transit (Massachusetts Bay Transportation Authority (MBTA) Airport Station), along Porter Street, and surrounding East Boston neighborhoods.	**Implemented.**
Provide street and pedestrian-level lighting and advanced warning signals and/or systems at crosswalks.	**Implemented.**
Transportation Demand Management (TDM) Plan	
Provide limited SWSA employee parking on-site.	**Implemented.**
Provide new access to public transit through the Unified Bus System (direct connection to MBTA Blue Line at Airport Station) and new/enhanced pedestrian facilities at the station.	**Implemented.**
Require rental car companies to participate in the Logan Transportation Management Association (TMA).	**Implemented.** This requirement is included in the RCC tenant leases.
Alternative-Fuel Vehicles	
The rental car companies would provide fuel-efficient and/or alternative-fueled rental vehicles (quantity to be determined by the rental car companies).	**Implemented.** This requirement is included in the RCC tenant leases.

Table 9-6 Southwest Service Area (SWSA) Redevelopment Program (EEA # 14137) Details of Ongoing Section 61 Mitigation Measures (as of December 31, 2018) (Continued)

Mitigation Measure	Status
Off-Airport Improvements/Benefits	
Reconstruct Frankfort Street/Lovell Street intersection to provide a new traffic signal control and pedestrian-related improvements (for temporary impacts of the relocation of the Bus and Limousine Pools to the North Service Area (NSA) during construction).	**Implemented.**
Reduce the amount of off-Airport car shuttling to and from off-Airport locations, further reducing traffic on Route 1A and local roadways surrounding the airport due to the consolidated and expanded rental car "ready/return" parking spaces and QTA areas at the SWSA.	**Implemented** upon project opening.

Source: Massport.
Note: The mitigation measures in *italics* are those that were referenced in FAA's ROD, and later incorporated into the Section 61 Findings as amended on June 29, 2010.

Logan Airport Runway Safety Area (RSA) Project – EEA #14442

Permitting History

- Certificate on the Final EA/EIR issued on March 18, 2011.
- FAA issued a FONSI on April 4, 2011, which documents that the proposed federal action is consistent with the National Environmental Policy Act of 1969 (NEPA) and other applicable environmental requirements and will not significantly affect the quality of the human environment with the mitigation requirements referenced in **Table 9-7**.
- Section 61 Findings were submitted to EEA on May 27, 2011, and published in the *Environmental Monitor* on June 8, 2011.
- Certificate on the Notice of Project Change (NPC) for the replacement of the Runway 33L approach light pier was issued on March 9, 2012.
- On April 12, 2012, the FAA found that the replacement of the Runway 33L approach light pier was a Categorical Exclusion and thus exempt from further consideration under NEPA.

Project Status

- The first construction season for the Runway 33L RSA commenced in June 2011 and was completed in November 2011. The second construction season started in June 2012 and was completed in November 2012.
- Replacement of the Runway 33L approach light pier commenced in July 2012 and was completed in November 2012. The upgraded Category III system was put in service in 2013.
- The Runway 22R improvements were completed in 2014.

As described in previous EDRs/ESPRs, Massport has periodically undertaken RSA improvement projects at other Logan Airport runways. Massport has completed safety improvements for Runways 22L, 4L/4R, and 27 under EEA #5122. In 2005, Massport began undertaking safety improvements at Runway 22R with the construction of an Engineered Materials Arresting System (EMAS) bed at the end of the runway in compliance with FAA directives, although no MEPA review was needed. In 2006, as part of a separate project, Massport installed an EMAS bed at the Runway 33L End. The Logan Airport RSA Project considered further enhancements to the Runway 33L and Runway 22R RSAs. Massport prepared a combined EA in accordance with NEPA and an EIR in accordance with MEPA for the proposed enhancements at the Runway 33L and Runway 22R RSAs. The ENF was filed with MEPA on June 30, 2009, and the Draft EA/EIR was submitted to the FAA and EEA on July 15, 2010. The Final EA/EIR was submitted to the FAA and EEA on January 31, 2011. **Figure 9-5** shows the location of RSA projects at Logan Airport.

The Runway 33L RSA improvements include a 600-foot long RSA with an EMAS bed, portions of which are on a 460-foot long by 300-foot wide pile-supported deck extending over Boston Harbor. Additional elements of the RSA improvements include two emergency access ramps located on either side of the deck and relocation of the perimeter access road. Construction of the pile-supported deck was completed in November 2012.

The Runway 33L RSA project replaced the inner 500 feet of the light pier. As construction progressed on the Runway 33L RSA improvements, Massport determined that it would be feasible to replace the remaining Runway 33L approach light pier. In the summer of 2012, Massport began replacing approximately 1,900 feet of the existing timber light pier that extends approximately 2,400 feet southeast of Runway End 33L. The existing timber pier was replaced with a new concrete structure along the runway centerline, approximately 10 feet south of the old pier, using concrete pilings. The in-kind replacement reduced the total number of pilings significantly (from over 500 to approximately 150). As part of the reconstruction, the new light pier was also constructed to accommodate upgraded navigational aids. The pier improvements provide the infrastructure necessary to support navigational aids that facilitate implementation of the reduced aircraft approach minimums previously reviewed and approved by the FAA in a ROD dated August 2, 2002, for the Logan Airside Improvements Planning Project (Airside Project) (EEA #10458). Massport filed an NPC with MEPA for the proposed light pier replacement on January 31, 2012. On March 9, 2012, the EEA Secretary issued an NPC Certificate determining that no further MEPA review was required for the light pier replacement. On April 12, 2012, the FAA found that the replacement of the Runway 33L approach light pier was eligible for a Categorical Exclusion and thus exempt from further review under NEPA.

The Runway 22R improvements that were completed in 2014 enhanced the existing RSA at this location by constructing an ISA similar to the ISA constructed at the Runway 22L end. Construction of the Runway 22R ISA is completed. **Table 9-7** lists the Section 61 mitigation commitments for the Logan Airport RSA Project and Massport's progress in achieving these measures.

FIGURE 9-5 Runway End Safety Improvements

2017 Environmental Status and Planning Report

◆ Runway End Safety Improvements

0 500 1000 2000 Feet

Table 9-7 Logan Airport Runway Safety Area Improvement Program (EEA # 14442) Section 61 Mitigation Commitments to be Implemented (as of December 31, 2018)

Mitigation Measure	Status
Protected Resources	
Eelgrass (Runway-End 33L Only)	
Develop a mitigation program that will replace lost eelgrass area and functions by creation of new eelgrass, at a 3:1 replacement to loss ratio.	**Implemented.** Eelgrass was transplanted in 2011, but did not survive through 2012. In 2013, state and federal agencies agreed that Massport's implementation of a conservation mooring program would be a suitable replacement alternative to the initial eelgrass transplant. In 2015, Massport completed the replacement of nearly 240 traditional moorings, located in eelgrass habitat, with conservation moorings. The moorings are located in Boston and four other Commonwealth harbors. Under contract to Massport, the Massachusetts Division of Marine Fisheries (MassDMF) conducted monitoring of the installations in 2014, 2015, 2016, 2017, and 2018.
Salt Marsh (Runway-End 22R Only)	
Restore new salt marsh at a 2:1 replacement to loss ratio.	**Implemented** as part of Runway 22R habitat mitigation at Rumney Marsh. Construction was completed in 2016. Monitoring is continuing.
Monitor compensatory salt marsh for success and invasive plant species, and implement an invasive species control plan.	**Implemented** upon completion of Runway 22R habitat mitigation at Rumney Marsh in 2017.
Shellfish	
Monitor pilings and substrate at Runway 33L.	**Implemented.** Monitoring was conducted in the summers of 2013, 2014, 2015, and 2017. Based on the 2017 monitoring report, the Massachusetts Department of Environmental Protection (MassDEP) determined that this mitigation commitment had been satisfied and that no further monitoring is required.
Restore approximately 1.1 acres of habitat.	**Implemented** as part of habitat mitigation at Rumney Marsh.
Harvest and transplant shellfish from the footprint of the Runway 22R Inclined Safety Area (ISA).	**Not Implemented.** MassDMF identified a risk of shellfish disease in the Logan Airport flats, including Runway 22R, and determined that the shellfish should not be relocated.
Execute Memorandum of Agreement (MOA) with the Massachusetts Division of Marine Fisheries for resource enhancement.	**Implemented.** A MOA with MassDMF was executed on July 30, 2012 and all requirements of the MOA have been implemented.
State-Listed Rare Species	
Identify equivalent area of pavement for removal to maintain area of available habitat at Logan Airport for the upland sandpiper if required by the Massachusetts Natural Heritage and Endangered Species Program.	**To be implemented.** The Massachusetts Natural Heritage and Endangered Species Program (NHESP) has determined that construction time-of-year restrictions will avoid impacts to state-listed species. The seasonal restrictions were implemented in 2018 during construction of Taxiway C-1.

Table 9-7 Logan Airport Runway Safety Area Improvement Program (EEA # 14442) Section 61 Mitigation Commitments to be Implemented (as of December 31, 2018) (Continued)

Mitigation Measure	Status
Protected Resources	
Cultural Resources	
Develop an Unanticipated Discovery Plan in accordance with the Board of Underwater Archaeological Resources' Policy Guidance.	**Implemented.** An Unanticipated Discovery Plan was developed in accordance with the Board of Underwater Archaeological (BUA) Resources' Policy Guidance and approved by BUA. No resources were discovered during construction.
Water Quality	
Develop and implement a comprehensive Soil Erosion and Sediment Control Plan in accordance with National Pollutant Discharge Elimination System (NPDES) and MassDEP standards.	**Implemented.** A comprehensive Soil Erosion and Sediment Control Plan was developed and implemented at the outset of Runway 33L construction in June 2011 and maintained through the end of construction in 2012.

Source: Massport.
Note: The mitigation measures in *italics* are those that were referenced in FAA's ROD and later incorporated into the Section 61 Findings as amended on May 27, 2011.

Terminal E Modernization – EEA #15434

Permitting History

- Certificate on the ENF issued on December 16, 2015.
- Certificate on the Draft EIR issued on September 16, 2016.
- Certificate on the Final EIR issued on November 10, 2016
- Section 61 Findings approved on January 19, 2017.
- FAA FONSI/ROD issued on November 14, 2016.

Project Status

The Terminal E Modernization Project will add seven new gates to Terminal E (three of which were already approved under MEPA in 1996 but were never constructed). The existing concourse, terminal core, and terminal roadway frontages (collectively, the "Project") will also be extended. Implementation of the Project will better accommodate the current and projected increased demand for international travel that is expected to occur whether or not the Project is implemented.

Initial construction on the project began in 2019. To accommodate this initial phase of construction, a replacement Logan Gas Station is being constructed in the SWSA along Jeffries Street. Upon completion of the first four gates, work on the remaining three gates will continue, including an associated passenger holdroom space and expansion of the U.S. Customs and Border Protection Immigration and Naturalization Service Corridor. Where common utilities and infrastructure are needed to serve both construction periods, that work is expected to commence during the construction of the first four gates.

Figure 9-6 shows the location of the Terminal E Modernization Project. **Table 9-8** lists each of the Section 61 mitigation commitments for the Terminal E Modernization Project and Massport's progress in achieving these measures. Massport provided two status reports to the FAA (one on May 25, 2018 and the second on April 10, 2019. Future ESPRs and EDRs will provide updates, as available.

FIGURE 9-6 Terminal E Modernization Project

2017 Environmental Status and Planning Report

◆ Terminal E Modernization Project - EEA #15434

Table 9-8 Terminal E Modernization Project (EEA #15434)
Details of Ongoing Section 61 Mitigation Measures (as of December 31, 2018)

Mitigation Measure	Status
Overall Project Benefits	
Provide pedestrian access between Terminal E and Massachusetts Bay Transportation Authority (MBTA) Airport Blue Line-Station.	Upon completion of this project and following a broader ground transportation strategy and planning process, a covered pedestrian connection between Terminal E and the MBTA Blue Line Airport Station will be constructed to improve passenger convenience. The type of connection is currently being studied; various approaches are under consideration and will be further documented in subsequent environmental filings and Environmental Data Reports (EDRs).
Construct roadway and curb improvements to improve vehicle flow, high occupancy vehicle (HOV) access, and reduce air and GHG emissions.	Final design is being advanced consistent with the commitments in the Final Environmental Assessment (EA)/Environmental Impact Report (EIR).
Site Terminal E additions so as to buffer the adjacent neighborhoods from aircraft noise.	Final design is being advanced consistent with the commitments in the Final EA/EIR.
Seek Leadership in Energy and Environmental Design (LEED®) certification at Silver level or better; meet or exceed Massachusetts (MA) LEED Plus program goals.	Final design is being advanced consistent with the commitments in the Final EA/EIR.
Provide 400 Hz of power and pre-conditioned air at the new aircraft gates.	400 Hz power and preconditioned air will be installed at the new gates when constructed.
Site Planning and Sustainable Design/Greenhouse Gas Reduction	
Incorporate sustainable design in design, construction, and operations including:	Final design is being advanced consistent with the commitments in the Final EA/EIR.
▪ *Improved building envelope*	Final design is being advanced consistent with the commitments in the Final EA/EIR.
▪ *Improved Air Handling Units;*	Final design is being advanced consistent with the commitments in the Final EA/EIR.
▪ *Efficient water loops*	Final design is being advanced consistent with the commitments in the Final EA/EIR.
▪ *Reduced interior lighting power density*	Final design is being advanced consistent with the commitments in the Final EA/EIR.
▪ *Specify roofing materials with a minimum reflectance rating of 0.70 and emittance value of at least 0.75 for a minimum of 75% of the available roof area. Install non-glare roofing materials.*	Final design is being advanced consistent with the commitments in the Final EA/EIR.
▪ *Incorporate infrastructure for collection, storage, and handling of recyclable materials.*	Final design is being advanced consistent with the commitments in the Final EA/EIR.

Table 9-8 Terminal E Modernization Project (EEA #15434)
Details of Ongoing Section 61 Mitigation Measures (as of December 31, 2018) (Continued)

Mitigation Measure	Status
▪ *Require contractor to develop a construction waste management plan that requires diversion or reduction of construction waste by at least 75%.*	Final design is being advanced consistent with the commitments in the Final EA/EIR.
▪ *Establish a project-specific goal for sourcing materials extracted, harvested, recovered, and or manufactured within New England.*	Final design is being advanced consistent with the commitments in the Final EA/EIR.
▪ *Design project to achieve energy efficiencies of a minimum of 20% below the MA Energy Code.*	Final design is being advanced consistent with the commitments in the Final EA/EIR.
▪ *Include water conservation devices that reduce water use by 20% below code.*	Final design is being advanced consistent with the commitments in the Final EA/EIR.
▪ *Include a minimum of 25,000 square feet of roof top solar photovoltaic system (approximately 300kW). Heat restroom hot water with solar units.*	Final design is being advanced consistent with the commitments in the Final EA/EIR. The Terminal E expansion includes a planned 300,000-kilowatt hour (kWh) rooftop solar array. In addition, the Terminal E garage project is reviewing options for the installation of solar panels.
▪ *Incorporate occupancy sensors in all indoor areas to reduce electrical demand.*	Final design is being advanced consistent with the commitments in the Final EA/EIR.
▪ *Evaluate other energy efficiency/greenhouse gas reduction measures as project design progresses.*	The Draft EA/EIR recommended several additional actions for furthering energy efficiency, greenhouse gas reduction, and resiliency, which the project team must strongly consider and for which it must document a decision in the Final EA/EIR. Final design is being advanced consistent with the decisions on these measures, as recorded in the Final EA/EIR.
Air Quality	
Reduce operational-related carbon dioxide (CO_2) emissions associated with the Project by a minimum of 30% percent.	Final design is being advanced consistent with the commitments in the Final EA/EIR.
Stormwater Management	
Replace and upgrade stormwater management.	Final design is being advanced consistent with the commitments in the Final EA/EIR.
Construction Period Impacts	
In accordance with DEP's Clean Air Construction Initiative, the Authority will require that construction contractors to install emission control devices such as diesel oxidation catalyst and/or particulate filters on certain equipment types (i.e., front-end loaders, backhoes, excavators, cranes, and air compressors).	These measures will be incorporated during construction.

Table 9-8 Terminal E Modernization Project (EEA #15434)
Details of Ongoing Section 61 Mitigation Measures (as of December 31, 2018) (Continued)

Mitigation Measure	Status
Retrofitting of certain construction equipment types with emission controls such as diesel oxidation catalyst and/or particulate filters.	These measures will be incorporated during construction.
Selection of high efficiency "temporary" space heating /cooling systems.	These measures will be incorporated during construction.
Remediate subsurface contamination, as necessary, if encountered during tank removals or other excavation activities as part of construction (in compliance with the Massachusetts Contingency Plan).	These measures will be incorporated during construction.
Soil treatment and reuse on site as part of a Soil Management Plan.	These measures will be incorporated during construction.
Voluntary compliance with the requirements of City of Boston noise ordinances, including restrictions on the types of equipment that can be used, and limitations on the hours when certain activities can take place (the City of Boston noise ordinance establishes restrictions during the construction hours between 7:00 PM and 7:00 AM).	These measures will be incorporated during construction.
Construction worker vehicle trip limitation, including requiring contractors to provide off-Airport parking and use of high-occupancy vehicle transportation modes for employees.	These measures will be incorporated during construction.
Implement Indoor Air Quality (IAQ) Management Plan during construction.	These measures will be incorporated during construction.
Construction Traffic Operations	
Construction-related traffic will be required to access and egress through the North Gate using only state and federal highways and the Airport roadway network. Construction- related traffic on local East Boston roadways will be prohibited.	These measures will be incorporated during construction.
Construction Traffic Operations	
Construction employee parking spaces will not be permitted on the construction site nor will provisions be made for them elsewhere on-Airport with the exception of a small number of spaces for supervisory personnel. The Authority will require contractors on this Project to implement construction worker vehicle trip management measures, including requiring off-Airport parking and HOV transportation modes for contractor employees.	These measures will be incorporated during construction.
Police details will be employed, as needed, to manage traffic and ensure public safety.	These measures will be incorporated during construction.
Construction Air Quality	

Table 9-8 Terminal E Modernization Project (EEA #15434)
Details of Ongoing Section 61 Mitigation Measures (as of December 31, 2018) (Continued)

Mitigation Measure	Status
Construction emissions will be reduced and controlled by mandatory contractor implementation of the following best practices:	These measures will be incorporated during construction.
Encouragement for construction-worker site access/egress using dedicated buses and vans;	These measures will be incorporated during construction.
Reduction of exposed erodible surface areas to the extent feasible;	These measures will be incorporated during construction.
Covering of exposed surface areas with pavement or vegetation in an expeditious manner and periodic watering;	These measures will be incorporated during construction.
Minimizing equipment idling times;	These measures will be incorporated during construction.
Reduction of on-site vehicle speeds;	These measures will be incorporated during construction.
Ensuring contractor implementation of appropriate fugitive dust and equipment exhaust controls;	These measures will be incorporated during construction.
Use of low- or zero-emissions equipment to the maximum extent feasible; and	These measures will be incorporated during construction.
Use of covered haul trucks during materials transportation.	These measures will be incorporated during construction.
Construction Noise	
Require construction equipment to deploy noise-reduction measures, such as the use of proper mufflers, measures to limit noise from truck traffic. Primarily operate only during daylight hours (7:00 AM to 7:00 PM).	These measures will be incorporated during construction.

This Page Intentionally Left Blank.

MEPA Appendices

- Appendix A, MEPA Certificates and Responses to Comments
- Appendix B, Comment Letters and Responses
- Appendix C, Proposed Scope for the *2018/2019 EDR*
- Appendix D, Distribution

This Page Intentionally Left Blank.

A

MEPA Certificates and Responses to Comments

- Secretary of the Executive Office of Energy and Environmental Affairs Certificate on the *Logan Airport 2016 Environmental Data Report (EDR)* and Massport's Responses to Comments raised in the Certificate.
- Secretary of the Executive Office of Energy and Environmental Affairs Certificate on the *Logan Airport 2016 EDR Notice of Project Change* and Massport's Responses to New Comments raised in the Certificate.
- Copies of the Secretary of the Executive Office of Energy and Environmental Affairs Certificates issued for the reporting years 2015, 2014, 2012/2013, and 2011.
- Copy of the Secretary of the Executive Office of Energy and Environmental Affairs Certificate issued for the Terminal E Modernization Project Environmental Notification Form.
- Copy of the Secretary of the Executive Office of Energy and Environmental Affairs Certificate issued for the Terminal E Modernization Project Draft Environmental Assessment/Environmental Impact Report.
- Copy of the Secretary of the Executive Office of Energy and Environmental Affairs Certificate issued for the Terminal E Modernization Project Final Environmental Assessment/Environmental Impact Report.
- Copy of the Secretary of the Executive Office of Energy and Environmental Affairs Certificate issued for the Logan Airport Parking Project Environmental Notification Form.

This Page Intentionally Left Blank.

Secretary of the Executive Office of Energy and Environmental Affairs Certificate on the *Logan Airport 2016 Environmental Data Report (EDR)* and Massport's Responses to Comments raised in the Certificate

This Page Intentionally Left Blank.

The Commonwealth of Massachusetts
Executive Office of Energy and Environmental Affairs
100 Cambridge Street, Suite 900
Boston, MA 02114

Charles D. Baker
GOVERNOR

Karyn E. Polito
LIEUTENANT GOVERNOR

Matthew A. Beaton
SECRETARY

Tel: (617) 626-1000
Fax: (617) 626-1181
http://www.mass.gov/envir

August 10, 2018

CERTIFICATE OF THE SECRETARY OF ENERGY AND ENVIRONMENTAL AFFAIRS
ON THE
2016 LOGAN AIRPORT ENVIRONMENTAL DATA REPORT

PROJECT NAME	: 2016 Environmental Data Report (EDR)
PROJECT MUNICIPALITY	: Boston/Winthrop
PROJECT WATERSHED	: Boston Harbor
EOEA NUMBER	: 3247
PROJECT PROPONENT	: Massachusetts Port Authority
DATE NOTICED IN MONITOR	: May 23, 2018

As Secretary of Executive Office of Energy and Environmental Affairs (EEA), I hereby determine that the Environmental Data Report submitted on this project **adequately and properly complies** with the Massachusetts Environmental Policy Act (MEPA) (M.G.L. c. 30, ss. 61-62I) and with its implementing regulations (301 CMR 11.00).

<u>Logan Airport Environmental Review and Planning</u>

The environmental review process for Logan Airport has been structured to occur on two levels: airport-wide and project-specific. The Environmental Status and Planning Report (ESPR) has evolved from a largely retrospective status report on airport operations to a broader analysis that also provides a prospective assessment of long-range plans. It has thus become, consistent with the objectives of the MEPA regulations, part of the Massachusetts Port Authority's (Massport) long-range planning process. The ESPR provides a "big picture" analysis of the environmental impacts associated with current and projected activity levels, and presents a comprehensive strategy to minimize impacts.

The ESPR is generally updated on a five-year basis. The most recent ESPR for the year 2011 was filed in April of 2013. Environmental Data Reports (EDRs) (formerly referred to as Annual Updates) are filed in the years between ESPRs.

EDRs consist of a status report and annual reporting on activity levels and associated environmental impacts at Logan Airport. ESPR's are also supplemented by (and ultimately incorporate) project-specific Environmental Impact Reports (EIR) that provide detailed analyses and mitigation commitments for proposed projects.

Through these reports, Logan Airport is subject to comprehensive and regular MEPA review, including opportunities for public comment on cumulative impacts. This regular updating and reporting on planning and cumulative impacts is unique among State Agencies. It reflects the challenge and complexity of managing and modernizing Logan Airport within a dense, urban area. It recognizes that the proximity of communities to the Airport warrants an enhanced level of public engagement and a concerted, long-term effort to minimize and mitigate impacts.

In February, 2018, Massport submitted a Notice of Project Change (NPC) regarding a request to shift the timing and sequence of the 2016 ESPR and 2017 EDR. The NPC indicated that 2016 was not an appropriate baseline year from which to forecast long-term operational and environmental conditions. The concern was based on changes associated with: (1) rapidly growing domestic and international passenger demand; (2) the formal introduction to Logan Airport of transportation network companies (TNC), such as Uber and Lyft; and (3) use of the Federal Aviation Administration's (FAA) Aviation Environmental Design Tool (AEDT) for noise and air quality modeling for 2016 reporting.

The sequence and timing for submitting ESPRs and EDRs had been adjusted previously based on consultation between Massport and the Executive Office of Energy and Environmental Affairs (EEA). Most recently, with EEA approval, Massport deferred submittal of the 2011 ESPR by two years based on the regional and national economic downturn experienced in the mid- to late-2000s. In a certificate on March 9, 2018 I granted the request to submit a 2016 EDR in lieu of the ESPR and issued the Scope for the EDR.

In 2016, passenger activity at Logan Airport has continued to grow faster than previous forecasts. A significant portion of growth in passengers is driven by an increase in demand for international air service. Massport has responded to this demand by providing new service to international destinations and expanding service to existing destinations. As passenger levels have increased, aircraft operations remain significantly below the peak of 507,449 operations experienced in 1998 when Logan Airport served 26.5 million passengers. The reduction of over 130,000 annual flight operations combined with transition towards newer and larger aircraft with improved environmental performance and operational efficiencies, have supported passenger growth while limiting environmental impacts.

The long-term trend is towards more efficient operations and significant reductions in overall environmental impacts. Although environmental impacts are significantly lower

compared to 1998 when operations were highest, comparison of activity level and environmental impact data to 2014 and more recent EDRs identifies increases in noise exposure, air emissions and traffic. These increases were not forecast in the 2011 ESPR. The increases are associated with passenger growth, changes in flight patterns and changes in modeling of noise and air quality. The 2016 EDR indicates that terminals, roadways and parking facilities are strained by these increases.

Logan Airport passenger ground access is changing rapidly with the use of TNCs for departures and arrivals at the Airport. Massport has been collecting TNC data since 2017 when TNCs were authorized to pick up customers from the airport. The 2016 EDR provides partial data for 2016 and identifies effects of TNCs. The 2017 ESPR will provide improved data and assessment of ground access trends.

The most significant change since 2011 is the introduction by the FAA of changes to area navigation (RNAV) procedures. The RNAV program has been implemented throughout the country and its primary purpose is to increase safety and operational efficiency. The implementation of several of these procedures has resulted in concentrations of flight patterns over certain communities and significant increases in noise exposure.

The impact of the RNAV program is emphasized in comment letters received on the 2016 EDR and also during review of specific projects, including the Terminal E Modernization Project (EEA# 15434). Massport and the FAA signed a Memorandum of Understanding (MOU) in 2017 to frame a new process for analyzing opportunities to incrementally reduce noise through changes or amendments to Performance Based Navigation, including RNAV procedures.

The 2016 EDR introduces emissions and noise modeling based on AEDT rather than the Integrated Noise Model (INM). Massport had deferred use of the AEDT until Massport made adjustments.

Subsequent ESPRs and EDRs will document potential impacts and trends and propose measures to avoid, minimize and mitigate environmental impacts.

Review of the 2016 EDR and Scope for the 2017 ESPR

The 2016 EDR identifies passenger activity and aircraft operational levels; provides updates on projects, environmental management plans and the status of project mitigation; includes a description and analysis of changes which will influence results and projections of the 2017 ESPR; and it includes a Scope for the 2017 ESPR.

The 2017 ESPR is an opportunity to update the cumulative impacts of passenger growth and associated ground and aircraft operations based on revised forecasts, documented trends and environmental impacts. The next ESPR will analyze calendar year 2017 and provide projections through 2035. It should follow the general format of the 2011 ESPR and include an Executive Summary (translated into Spanish) and Introduction, similar to previous ESPRs and EDRs.

The 2017 ESPR must include information on the environmental policies and planning that form the context of environmental reporting, technical studies, and environmental mitigation initiatives against which projects at Logan Airport can be evaluated. This should include identification of the cumulative effects of Logan Airport operations and activities, compared to previous years, as appropriate. The results of the Logan Airport Air Passenger Ground Access Survey and the Long-term Parking Management Plan should inform transportation planning and strategies to achieve the HOV mode share goal.

The ESPR must include copies of all ESPR and EDR Certificates and a distribution list for the 2017 ESPR (indicating those receiving documents, CDs, or Notices of Availability). Supporting technical appendices should be provided as necessary.

Response to Comments

The Response to Comments section should address all of the substantive comments on the 2016 EDR, and other Certificates for Logan Airport that reference EDR/ESPR documentation (e.g. Logan Airport Parking Project, Terminal E). To ensure that the issues raised by commenters are addressed, the 2017 ESPR should include direct responses to comments to the extent that they are within MEPA jurisdiction. This directive is not intended to, and shall not be construed to, enlarge the scope of the 2017 ESPR beyond what has been expressly identified in this Certificate. I recommend that the Massport continue to use the format from the 2016 EDR. The Responses to Comments should not reference a section of the 2017 ESPR unless they are directly responsive to the comment. Common themes that should be addressed throughout the ESPR and in the Responses to Comments include noise (modeling of noise contours and noise abatement) and emissions reduction issues. The 2017 ESPR should include sufficient information to address comments on traffic, air quality and public health which are common concerns of commenters.

Activity Levels

Air traffic activity levels at Logan Airport are the basis for the evaluation of noise, air quality, and ground access conditions associated with the Airport. In this section, current activity levels at the Airport are compared to prior-year levels, and historical passenger and operations trends at Logan Airport dating back to 2000 which is the year Massport approved an Environmental Management Policy. The total number of air passengers increased by 8.5 percent to 36.3 million in 2016, compared to 33.4 million in 2015. The 2016 passenger level represents a record high for Logan Airport.

Passenger aircraft operations accounted for 90.4 percent of total aircraft operations in 2016. The total number of aircraft operations at Logan Airport increased by 4.9 percent from 372,930 in 2015 to 391,222 in 2016. Aircraft operations continue to increase from 2010 levels and remain below the 487,996 operations in 2000 and the historical peak of 507,449 in 1998.

Air carrier efficiency continued to improve in 2016 as the average number of passengers per aircraft operation at Logan Airport grew from 89.7 in 2015 to 92.8 in 2016. The increasing number of passengers per flight reflects a shift away from smaller aircraft and rising load factors

as airlines continue to focus on capacity control and improvements in efficiency. This trend is indicative of the industry-wide shift toward higher aircraft load factors and an increase in the number of domestic and international destinations. Annual domestic passenger activity levels increased from 27.8 million in 2015 to 29.6 million in 2016, a 6.4 percent increase. International passenger demand continues to increase at a faster rate than domestic passenger demand. International passengers increased from 5.5 million in 2015 to 6.6 million in 2016, a 19 percent increase. The 2016 EDR indicates that strong international passenger growth was driven by the economic attractiveness of the metropolitan Boston region and the strength of Boston as an origin and destination market. In response to regional demand for international service, new non-stop services were introduced by a number of airlines including Air Berlin, Norwegian Air Shuttle, Qatar Airways, Scandinavian Airlines, and TAP Air Portugal. New international destinations from Logan Airport in 2016 included Dusseldorf, London Gatwick, Doha, Copenhagen, and Lisbon.

Passenger activity has continued to grow faster than forecasts provided in the 2016 EDR. It is expected that Logan Airport will reach 40 million annual passengers by 2019. The ESPR should describe how Massport will achieve long-standing goals to reduce overall operating and environmental impacts at the airport as passengers and, in particular, international passengers increase. Discussion of passenger and activity levels and planning/mitigation to address impacts of that growth, in particular air and noise emissions, should be a significant emphasis of the ESPR.

The 2017 ESPR should report on:

- Aircraft operations, including fleet mix and scheduled airline services at Logan Airport;
- Domestic and international passenger activity levels;
- Cargo and mail volumes;
- Comparison of 2017 operations and passenger activity levels to 2016 activity levels; and
- National aviation trends compared to Logan Airport trends.

The 2017 ESPR should update the Logan Airport long-term passenger forecast to reflect growth trends at Logan Airport and revised expectations for the local/national/international economy. Planning and impact sections will be based on forecasting for the next five years through 2035. It should address methodologies and assumptions used in the analysis, including anticipated changes to fleet mix changes and other trends in the aviation industry. It should also provide:

- Updated forecasts for passenger volume, aircraft operations, and fleet mix;
- A comparison of 2017 operations to historic trends and 2035 forecasts; and
- A comparison of forecast activity levels to Massport forecasts from previous ESPRs, FAA forecasts and the U.S. aviation industry.

<u>Sustainability at Logan Airport</u>

The 2016 EDR described Massport's airport wide sustainability goals as identified in the EMP and 2016 Sustainability Management Plan (SMP). The SMP identifies efforts to promote,

coordinate and integrate sustainability Airport-wide. Progress towards achieving these goals was addressed in the 2016 EDR. The 2017 ESPR should update progress on these goals.

Climate Change

Massport assets and Logan Airport, in particular, are critical infrastructure and play an important role in the economy. As recognized in Governor Baker's recent Executive Order 569 "Establishing an Integrated Climate Change Strategy for the Commonwealth" and a suite of other state and municipal initiatives, the impacts of climate change must be an important consideration for development across the state. Climate change presents a serious threat to the environment and the Commonwealth's residents, communities and economy. The EO indicates that extreme weather events associated with climate change present a serious threat to public safety and the lives and property of our residences. The recent flooding and storm damage caused by two storms in early March underscore these risks and the importance of adaptation and resiliency planning.

The EO also identifies the transportation sector as a significant contributor to GHG emissions in the Commonwealth and the only sector in which GHG emissions are increasing. In 2017, EEA and the Massachusetts Department of Transportation (MassDOT) conducted a number of transportation listening sessions throughout the Commonwealth to inform development of strategies and programs to reverse the growth in this sector.

Consistent with EO 569, the Massachusetts State Hazard Mitigation and Climate Adaptation Plan and the Massachusetts Energy Plan will be released in September. The ESPR should address the project's consistency with these plans.

Massport has begun reporting on GHG emissions and, in recognition of the potential effects of climate change on Massport infrastructure and operations, Massport initiated a Disaster and Infrastructure Resiliency Planning (DIRP) Study.

GHG emissions

The 2016 EDR contains a greenhouse gas (GHG) emissions inventory for the Logan Airport EDR. The 2016 EDR presented emissions and energy data normalized by passenger use and building area. GHG emissions associated with buildings and transportation were presented as pounds of CO_2 per passenger. GHG emissions for buildings were presented as pounds of CO_2 per sf per year. Energy use for buildings were presented as kBtu per sf per year. Ten years of data was provided in the 2016 EDR for each of these. The analysis showed that Massport has reduced emissions per passenger across its operations by 34 percent in the last decade. Building energy use has been reduced 23 percent while building emissions have been reduced 43 percent.

The 2017 ESPR should incorporate GHG emissions reporting consistent with that provided in the 2016 EDR which was normalized to support effective review and analysis. In addition, Massport should ensure that only conditioned (heated and cooled, enclosed buildings) building areas are included in energy use and emission intensity calculations, report input energy components (oil, gas, electricity) and central plant data and clarify how renewables are

accounted in the analysis. Massport should consult with the MEPA Office and the Department of Energy Resources (DOER) regarding presentation of GHG data in the 2017 ESPR and subsequent EDRs.

The 2017 ESPR GHG emissions should continue to be quantified for aircraft, GSE, motor vehicles and stationary sources using emission factors and methodologies outlined in the *Greenhouse Gas Emissions Policy and Protocol* issued by EEA and the Transportation Research Board's *Guidebook on Preparing Airport Greenhouse Gas Emissions Inventories* (Airport Cooperative Research Program (ACRP) Report 11, Project 02-06). The results of the 2017 GHG emissions inventory should be compared to the 2016 results.

Adaptation and Resiliency

A particular concern for Massport is the effect of sea level rise and projected increases in the severity and frequency of storms. The DIRP Study includes Logan Airport, the Port of Boston, and Massport's waterfront assets in South and East Boston. It includes a hazard analysis; modeling of projected sea-level rise and storm surge; temperature and precipitation projections; and anticipated increases in extreme weather events.

In addition to the DIRP Study and its related initiatives, Massport has completed an Authority-wide risk assessment; issued a Floodproofing Design Guide; and developed a resilience framework to provide consistent metrics for short- and long-term planning and protection of its critical facilities and infrastructure. Massport's Floodproofing Design Guide was updated in April 2016. Plans were also introduced in 2015 that included the deployment of temporary flood barriers to protect up to 12 locations of critical infrastructure in the event of severe weather.

The 2017 ESPR should provide a summary of the DIRP Study and identify which recommendations Massport will implement in the short term and long term.

<u>Mitigation</u>

The 2016 EDR identifies the status of mitigation commitments for specific Massport and tenant projects at Logan Airport that have undergone MEPA review. The 2017 ESPR will address cumulative, Airport-wide impacts. The 2017 ESPR should update the status of mitigation commitments for recent projects such as the Terminal E Modernization Project and the Logan Airport Parking Project as well as projects previously included in the EDRs.

<u>Planning</u>

The Airport Planning section describes the status of projects underway or completed at Logan Airport by the end of 2016. Specific topics include terminal area projects, service area projects, buffer/open space projects, Airport parking projects, airside area projects, high occupancy vehicle (HOV) improvements, and Airport-wide projects. Project updates include:

- *Terminal E Renovation and Enhancements Project*: This project includes interior and exterior improvements at Terminal E to accommodate regular service by wider and

longer Group VI aircraft. The project reconfigured three gates to accommodate Group VI aircraft (including the Airbus A380 and Boeing 747-8 primarily used by international air carriers) and passenger holdrooms to accommodate larger passenger loads associated with these aircraft. Construction was completed in early 2017.

- *Terminal E Modernization Project*: This project will accommodate existing and long range forecasted demand for international service. The expansion will add the three gates approved in 1996 (International Gateway West Concourse project, EEA #9791), which were never constructed, and an additional two to four additional new gates in an extended concourse. A key feature of this project is the first direct pedestrian connection from the MBTA Blue Line Airport Station to the terminal complex at Logan Airport. It will also include roadway improvements to facilitate access to the terminal. Phase 1 has been permitted and is in the final design stage.

- *Terminal C to E Airside Connector:* This project provides a new post-security connection between Terminals C and E on the Departures Level and provides improved passenger circulation within the post-security concourses, additional holdroom space at Terminal E, reconfigured office space, concessions and concessions support, and a new consolidated location for escalators and stairs. The project was completed in May 2016.

- *Terminal B Airline Optimization Project:* Massport is upgrading its facilities on the Pier B side of Terminal B to meet airlines' needs (primarily reflecting the merger of American Airlines and US Airways) and to provide facilities that improve the passenger traveling experience. Similar improvements have been implemented with the recent renovations and improvements at Terminal B, Pier A. Planned improvements include an enlarged ticketing hall; improved outbound bag area; and expanded bag claim hall, concession areas and holdroom capacity at the gate. Final design is complete and construction is underway. Construction is expected to be complete in early 2019.

- *Hangar Projects:* Architectural design commenced in December 2010 for two hangar upgrades in the North Cargo Area (NCA). The renovated JetBlue Airways hangar opened in 2012. The American Airlines hangar, formerly occupied by Northwest Airlines, was refurbished in 2013. Demolition of the former American Airlines hangar (Hangar 16) commenced in 2014 and was completed in August 2016.

- *Logan Airport Parking Project*: This project includes the construction of up to 5,000 new commercial parking spaces to reduce trip generation associated with increases in passenger drop-off and pick-up at the airport. The Certificate on the ENF was issued on May 5, 2017 and included a Scope for the Draft Environmental Impact Report (DEIR). The project required an amendment to the Logan Airport Parking Freeze Regulations (310 CMR 7.30). Amendments to the regulations were promulgated in 2017. The DEIR is under development and will identify the number of spaces, location of spaces and planned construction phasing.

- *Maintenance of Airport Edge Buffer Areas and Parks:* The 2016 EDR provides updates on the planning, construction, and maintenance of four Airport edge buffer areas and two

parks along Logan Airport's perimeter. As of 2016, the Bayswater Buffer, Navy Fuel Pier Buffer, SWSA Buffer Phase 1 and the SWSA Buffer Phase 2 have been completed. The Neptune Road Airport Edge Buffer opened in 2016. These buffers and parks include 3.3 miles and more than 33 acres of green space developed or managed by Massport.

The 2017 ESPR should continue to assess planning strategies for improving Logan Airport's operations and services in a safe, secure, more efficient, and environmentally sensitive manner. As owner and operator of Logan Airport, Massport must accommodate and guide tenant development. The ESPR should describe the status of planning initiatives for the following areas:

- Roadways and Airport Parking;
- Terminal Area;
- Airside Area;
- Service and Cargo Areas; and
- Airport Buffers and Landscaping.

The 2017 ESPR should also indicate the status of long-range planning activities, including the status of public works projects implemented by other agencies within the boundaries of Logan Airport. The ESPR should identify the status and assess effectiveness of ground access changes, including roadway and parking projects, that consolidate and direct airport-related traffic to centralized locations and minimize airport-related traffic on streets in adjacent neighborhoods.

Regional Transportation

The 2016 EDR describes activity levels at New England's regional airports in 2016 and provides an update on regional planning activities, including long-range transportation efforts. The New England region is anchored by Logan Airport and a system of 10 other commercial service, reliever, and general aviation (GA) airports (regional airports). In 2016, passenger traffic at the New England airports represented the highest passenger traffic level for the region since the economic downturn in 2008. The increase in the region's passenger traffic was largely driven by continued growth at Logan Airport. In 2015, the total number of air passengers utilizing New England's commercial service airports, including Logan Airport, increased by 6.4 percent, from 48.8 million air passengers in 2015 to 51.9 million air passengers in 2016. Of the 51.9 million passengers using New England's commercial service airports in 2016, 69.9 percent of passengers (36.3 million) used Logan Airport compared to 68.6 percent (33.5 million) in 2015.

The 2017 ESPR should report on:

Regional Airports
- 2017 regional airport operations, passenger activity levels, and schedule data within an historical context;
- Status of plans and new improvements as provided by the regional airport authorities;
- Role of the Worcester Regional Airport and Hanscom Field in the regional aviation system and Massport's efforts to promote these airports; and

- Ground access improvements at Massachusetts Regional Airports.

Regional Transportation System

- Massport's role in managing the regional transportation facilities within MassDOT;
- Massport's cooperation with other transportation agencies to promote efficient regional highway and transit operations; and
- Report on metropolitan and regional rail initiatives and ridership.

Ground Access to and from Logan Airport

The 2016 EDR reports on transit ridership, roadways, traffic volumes, and parking for 2016. Specifically, the EDR states that Massport has continued to invest in and operate Logan Airport with a goal of increasing the number of passengers arriving by transit or other HOV modes. The 2016 EDR provides a discussion of ground access modes and trip generation associated with each mode including: (1) transit and shared-ride HOV services; (2) drive to Logan Airport and park; or (3) drop-off/pick-up mode, which can involve a private vehicle, taxi, limousine, or TNCs.

Use of mobile application ride-booking services, such as Uber and Lyft, are increasingly becoming a mode of choice for ground access at Logan Airport. As noted previously, in 2017 Massport began allowing TNCs to pick-up arriving air passengers. The 2016 EDR provides data from the 2016 Logan Airport Air Passenger Ground-Access Survey that shows increased use.

Massport remains in compliance with the Parking Freeze regulations which regulates the number of commercial and employee parking spaces allowed at Logan Airport. Massport submits semi-annual compliance filings to MassDEP; March and September reports are provided in the 2016 EDR. As permitted (and encouraged) by the regulations, Massport has converted employee spaces to commercial spaces, within the overall limits.

The HOV/transit mode share at Logan Airport continues to rank at the top of U.S. airports. The 2016 EDR describes a multi-pronged trip reduction strategy to reduce the number of private vehicles that access Logan Airport and, in particular, the drop-off/pick-up modes. Measures implemented in 2016 by Massport to increase HOV use include a blend of initiatives related to pricing (incentives and disincentives), service availability, service quality, marketing, and traveler information.

At the same time, private passenger vehicle trips continue to increase as air travel grows. Massport has indicated that as passenger levels have increased, the constrained parking supply at Logan Airport has resulted in an increase in pick-up and drop-off vehicle trips. Despite an increase in terminal area parking rates on July 1, 2014, daily parking demand more frequently approached the Parking Freeze cap in 2015. As described previously, Massport is proposing to construct additional parking to reverse this trend. The 2016 EDR contained an outline of the proposed ground access study required by the Parking Freeze amendments. The results recommendations of this study will be presented in the 2017 ESPR.

Beginning with the 2017 ESPR, Massport will introduce a new definition for high occupancy vehicle (HOV) modes that will provide more accuracy. Under the current system, Massport identifies all taxis as non-HOV and TNCs as non-HOV and all black car limousines as HOV. Going forward, Massport will estimate HOV and non-HOV breakdowns for taxis, livery services, and TNCs based on whether there is more than one passenger. Consistent with the directive identified in the Certificate on the ENF for the Logan Airport Parking Project, and through negotiations with CLF, Massport has committed to a goal of 35.5 percent HOV by 2022 and 40 percent by 2027.

The Airport-wide Automated Traffic Monitoring System (ATMS) includes permanent traffic count stations at the Airport's gateway roadways. These stations provide data on annual average daily traffic (AADT), annual average weekday daily traffic (AWDT), and annual average weekend daily traffic (AWEDT). The AADT (entering and departing Logan Airport) increased by increased by 5.4 percent between 2015 and 2016. The change in average daily traffic can be attributed to: an 8.5-percent increase in air passenger activity in 2016; a 5.1-percent increase in taxi dispatches in 2016; and, the impact of TNCs (although this has not been quantified).

On-Airport VMT is calculated based on the total number of miles traveled by all vehicles within the Logan Airport roadway system. VMT is used to calculate motor vehicle air quality emissions, and it is also one indication of the levels of traffic on roadways in specific areas and at specific times. In 2011 as detailed in the 2011 ESPR, Massport upgraded its modeling capabilities and began using an on-Airport VISSIM-10 model to estimate VMT. The adjustment factors for the 2016 VMT calculations were determined by using 2011 to 2016 gateway, airport roadway, and parking volume averages.

The change in average weekday VMT between 2015 and 2016 was approximately 4.8 percent, despite higher increases in passenger levels (8.5 percent) and traffic volume (5.4 percent) during the same time period. Since 2000, the highest average weekday VMT estimated at Logan Airport was 184,613 in 2007. According to the 2016 EDR weekday VMT calculations remain about 4.4 percent lower than 2007, despite the 29.1 percent increase in air passenger traffic during the same time period. The 2016 EDR attributes this to the promotion of HOV modes. However, the 2016 EDR does not present a quantifiable comparison between VMT values prior to 2011 because the previous model was limited to terminal access roads while the current VMT model includes a larger on-Airport study area.

The 2016 EDR describes improvements to support HOV access which include: Back Bay Logan Express pilot service (since May 2014); free MBTA Silver Line outbound (from Logan Airport) boardings; a 1,100-car parking garage at the Framingham Logan Express; reduced holiday travel parking rates at Logan Express facilities; increased parking rates on the Airport; and support for private coach bus and van operators. In 2015, Massport acquired the 20-acre site that Massport previously leased for Braintree Logan Express. The site provides parking for 1,800 cars. The Braintree had a ridership of 655,158 passengers trips in 2016, representing 36 percent of the entire Logan Express system ridership. Approximately half of the Braintree Logan Express riders are Logan Airport employees. 2016 ridership for the Back Bay Logan Express totaled 216,329 passengers, an average of about 600 riders per day. In 2015, the service average

was 805 riders per day, with a total of 290,796 passengers. The EDR attributes the 26 percent reduction in ridership to the re-opening of the Government Center Station in March 2016 and the ending of free fares for riders with an MBTA pass and reduced fares for all others.

The 2017 ESPR should report on 2017 ground access conditions at the airport and provide a comparison to 2016 for the following:

- Description of compliance with Logan Airport Parking Freeze;
- High-occupancy vehicle (HOV) ridership (including Blue Line, Silver Line, Water Transportation, and Logan Express);
- Logan Airport Employee Transportation Management Association (Logan TMA) services;
- Logan Airport gateway volumes;
- On-airport traffic volumes;
- On-airport vehicle miles traveled (VMT);
- Parking demand and management (including rates and duration statistics);
- Status of long-range ground access management strategy planning;
- Results of the 2016 Logan Airport Air Passenger Ground Access Survey; and,
- Status of proposed connector to the Airport Station associated with the planned Terminal E Modernization Project.

The chapter should present a discussion of analytical methodologies and assumptions for the planning horizon year (2035) for traffic volumes, on-airport VMT and parking demand.

The 2017 ESPR should address the following topics:

- Target HOV mode share and incentives;
- Non-Airport through-traffic;
- Cooperation with other transportation agencies to increase transit ridership to and from Logan Airport via the Blue Line, Silver Line, Water Transportation, and Logan Express;
- Report on efforts to increase capacity and use of Logan Express;
- Progress on enhancing water transportation to and from Logan Airport;
- Results and recommendations of the ground access study Long-term Parking Management Plan required by the Parking Freeze amendments; and
- Strategies for enhancing services and increasing employee membership in the Logan Airport TMA.

Noise

The 2016 EDR updated the status of the noise environment at Logan Airport in 2016, and described Massport's efforts to mitigate noise exposure and impacts. The implementation of the aRea NAVigation (RNAV) Pilot study being jointly undertaken by FAA and Massport has resulted in concentration of flight patterns over certain communities and significant increases in noise exposure. The effects of this program are identified as significant concerns in the majority of comment letters.

The 2016 EDR provides noise modeling results from the AEDT (version 2c, Service Pack 2). The model requires detailed operational data as inputs for noise calculations, including numbers of operations per day by aircraft type and by time of day, which runway for each arrival and for each departure, and flight track geometry for each track. INM results are provided for comparison. The 2016 EDR also presents summaries of the 2016 operational data used in the noise modeling, as well as the resultant annual Day-Night Average Sound Level (DNL) noise contours, a comparison of the modeled results with measured levels from the noise monitoring system, and estimates of the population residing within various increments of noise exposure in 2016. Both FAA and the U.S. Department of Housing and Urban Development consider DNL exposure levels above 65 decibels (dB) to be incompatible with residential land use. The 2016 EDR identifies which noise abatement measures are being employed, describes the RNAV Pilot study being jointly undertaken by FAA and Massport, and provides a summary of the Boston Logan Airport Noise Study (BLANS).

Annual aircraft operations in 2016 increased from 372,930 operations in 2015 to 391,222 in 2016, a 4.9-percent increase. Passenger volumes are at an all time high increasing from 33.4 million passengers in 2015 to 36.3 million in 2016, an increase of 8.5 percent. Commercial traffic increased from 344,764 to 360,400, a 4.2-percent increase compared to 2015. In 2016, operations continued to shift from the smaller Regional Jet (RJ) aircraft to larger aircraft on many routes, increasing the number of passengers carried per operation.

Differences between measured and modeled values had narrowed in recent years as the processes were refined. Introduction of the AEDT has increased the differences. Runway use changes from 2015 to 2016 were the largest factor influencing noise exposure in 2016. The one-month closure of Runway 4L-22R for resurfacing caused air traffic to shift to Runway 15R-33L and Runway 9-27, and these changes in runway use are reflected in the noise contour changes presented in the 2016 EDR. An additional factor influencing noise contour changes in 2016 was an increase in nighttime operations, from 50,786 in 2015 to 55,499 in 2016.

Population exposed to DNL levels greater than or equal to DNL 65 dB noise levels for 2016 was 16,985 based on the legacy INM model, and 7,450 using the next-generation AEDT model. In 2016, noise complaints more than doubled. Massport received 38,045 noise complaints from 83 communities compared to 17,685 in 2015 from 84 communities.

The increase in complaints continues to be primarily related to the FAA's RNAV departure procedures, which concentrate flight tracks along narrower corridors. All complaints have been forwarded to FAA. The 2016 EDR also provides an update on the MOU between Massport and FAA to frame the process for analyzing opportunities to reduce noise through changes or amendments to Performance Based Navigation (PBN), including RNAV. Massport is working with the FAA to develop test projects designed to help address the concentration of noise from the PBN. The 2017 ESPR must provide strategies to address noise impacts which are expressed in numerous comments received on the 2016 EDR.

To date, Massport has provided sound insulation for a total of 11,515 residential units exposed to levels greater than or equal to DNL 65 dB, and will continue to seek funding for sound insulation for properties that are eligible and whose owners have chosen to participate. The 2017 ESPR should provide an overview of the environmental regulatory framework

affecting aircraft noise, the changes in aircraft noise, and the updates in noise modeling. The chapter should report on 2017 conditions and provide a comparison to 2016 for the following:

- Fleet Mix, including Stage II, Recertified Stage III, newly manufactured Stage III, and qualifying Stage IV aircraft;
- Nighttime operations;
- Runway utilization (report on aircraft and airline adherence with runway utilization goals);
- Preferential runway advisory system (PRAS) tracking; and
- Flight tracks.

The 2017 ESPR should report on the following:

- Changes in annual noise contours and noise-impacted population;
- Measured versus modeled noise values, including reasons for differences and any improvements attributable to the models deployed;
- Cumulative Noise Index (CNI);
- Times-Above for 65, 75, and 85 dBA threshold values/Dwell and Persistence of noise levels; and
- Flight track monitoring noise reports.

The 2017 ESPR should also report on noise abatement efforts, results from Boston Logan Airport Noise Study (BLANS) study, and provide an update on the noise and operations monitoring system.

Air Quality/Emissions Reduction

The 2016 EDR provided an overview of airport-related air quality issues in 2016 and efforts to reduce emissions. The air quality modeling is based on aircraft operations, fleet mix characteristics, and airfield taxiing times combined with ground support equipment (GSE) usage, motor vehicle traffic volumes, and stationary source utilization rates. Total air quality emissions from all sources associated with Logan Airport are significantly lower than a decade ago.

In 2016, calculated emissions of volatile organic compounds (VOCs), oxides of nitrogen (NOx), carbon monoxide (CO), and particulate matter (PM) went up slightly compared to 2015. The increase is primarily due to the corresponding increase in aircraft landing and take offs (LTOs), airfield taxi times, and modeling differences between the AEDT model and the Emissions Dispersion Modeling System (EDMS) which had been used in prior EDR filings. VOC, NOx, CO and PM were all is influenced by the increase in aircraft operations. In addition, the AEDT model estimates growth in the proportion of aircraft emissions for VOCs, NOX, and CO in comparison to EDMS. However, the opposite was true for PM10/ PM 2.5 where the EDMS model estimates a higher PM10/ PM 2.5 than the AEDT model. Total modeled emissions of VOCs increased by 7.7 percent in 2016 to 1,280 kilograms (kg)/day, compared to 1,188 kg/day in 2015. Modeled NOx emissions increased by 24.4 percent in 2016 to 5,300 kg/day compared to 4,262 kg/day in 2015. Total modeled CO emissions increased by 1.5 percent in

2016 to 7,350 kg/day compared to 7,243 kg/day in 2015. Total PM10/PM2.5 emissions have decreased by about 2 percent in 2016 to 96 kg/day from 98 kg/day in 2015.

The 2017 ESPR should contain an overview of the environmental regulatory framework affecting aircraft emissions, changes in aircraft emissions, and the changes in air quality modeling. The 2017 ESPR should also provide discussion on progress on the national and international levels to decrease air emissions. Massport should continue to use the FAA's AEDT model for air emissions modeling as was presented in the 2016 EDR.

The EPA Motor Vehicle Emission Simulator (MOVES) tool will continue to be used to assess vehicular emissions on airport roadways. The 2017 ESPR should include a mobile sources emissions inventory for CO, NOx, VOCs, and PMs. It should also report on Massport and tenant alternative fuel vehicle programs and the status of Logan Airport air quality studies undertaken by Massport or others, as available.

Commenters continue to express concern regarding ultrafine particulates (UFPs). The 2016 EDR includes information on the status of UFP review by the Environmental Protection Agency (EPA) and an update on associated research and monitoring. The ESPR should include updated information regarding potential regulation, research and monitoring of UFPs.

Massport should also provide an update on its efforts to encourage the use of single engine taxiing under safe conditions. In addition, the 2017 ESPR should provide an update on the feasibility of combined heat and power (CHP) use for Terminal E and updates to progress made in designing the energy systems for the facility.

Water Quality/Environmental Compliance

The 2016 EDR describes Massport's ongoing environmental management activities including National Pollutant Discharge Elimination System (NPDES) compliance, stormwater, fuel spills, activities under the Massachusetts Contingency Plan (MCP), and tank management. Massport's primary water quality goal is to prevent or minimize pollutant discharges, thus limiting adverse water quality impacts of airport activities. Massport employs several programs to promote awareness of activities that may impact surface and groundwater quality. Programs include implementing best management practices (BMPs) for pollution prevention by Massport, its tenants, and its construction contractors; training of staff and tenants; and a comprehensive stormwater pollution prevention plan.

The 2017 ESPR should identify any planned stormwater management improvements and report on the status of:

- NPDES Permit and monitoring results for Logan outfalls and the Fire Training Facility;
- Jet fuel usage and spills;
- MCP activities;
- Tank management;
- Update on the environmental management plan; and
- Fuel spill prevention.

Conclusion

Massport may prepare a 2017 ESPR for submission consistent with the Scope included in this Certificate. I encourage Massport to target early 2019 for filing of the 2017 ESPR.

August 10, 2018
Date

Matthew A. Beaton

Comments received:

06/17/2018	Gillian Anderson
06/18/2018	Luke Preisner
06/21/2018	James Morgan
06/22/2018	Nancy Timmerman
07/02/2018	Peter Houk
07/23/2018	Town of Milton, Board of Selectmen
07/31/2018	Cindy Christiansen
07/31/2018	GreenRoots
07/31/2018	Astrid Weins
07/31/2018	Dawn Quirk and Julia Wallerce
07/31/2018	Airport Impact Relief, Inc.
08/03/2018	Department of Energy Resources

MAB/ACC/acc

Comment #	Author	Topic	Comment	Response
A-1	Matthew Beaton, Secretary	Content	The next ESPR will analyze calendar year 2017 and provide projections through 2035.	This *2017 Environmental Status and Planning Report (ESPR)* provides 1990, 2000, and 2010-2017 data as available in each chapter. Each chapter of the document discusses calendar year 2017 findings and compares data to 2016 and historical years. The document includes data from 1990 and 2000, and in some cases 1998 (the year of peak operations at Logan Airport), to provide a historical benchmark of progress over the last few decades. In some cases, where 2018 data are available, they are provided. The technical appendices contain all available historical data. The scope for this document was established by the Secretary's Certificate dated August 10, 2018, which is included in Appendix A, *MEPA Certificates and Responses to Comments*. The *2017 ESPR* provides an analysis of 2017 through a Future Planning Horizon as reported in Chapter 2, *Activity Levels.*
A-2	Matthew Beaton, Secretary	Introduction / Spanish Translation	It should follow the general format of the 2011 ESPR and include an Executive Summary (translated into Spanish) and Introduction, similar to previous ESPRs and EDRs.	The *2017 ESPR* follows the *2011 ESPR* format. Massport has prepared summaries of past Environmental Data Reports (EDRs) and other environmental documentation in Spanish, to provide information to the community. Recently completed Spanish language documents can be found on Massport's website at http://www.massport.com/massport/about-massport/project-environmental-filings/logan-airport/. This *2017 ESPR* includes a Spanish translation of Chapter 1, *Introduction/Executive Summary*.
A-3	Matthew Beaton, Secretary	Content	The 2017 ESPR must include information on the environmental policies and planning that form the context of environmental reporting, technical studies, and environmental mitigation initiatives against which projects at Logan Airport can be evaluated.	The *2017 ESPR* includes the critical context information for reviewing agencies and the public to understand the purpose and scope of the elements reported in the ESPR, including the environmental conditions, technical studies, and mitigation initiatives. The *2017 ESPR* also describes the projects that are in the feasibility, planning and construction phases at Logan Airport, so that the public is aware of ongoing and upcoming activities.
A-4	Matthew Beaton, Secretary	Content	This should include identification of the cumulative effects of Logan Airport operations and activities, compared to previous years, as appropriate.	The *2017 ESPR* continues to report on cumulative, Airport-wide environmental conditions associated with operations and airport activities. Cumulative effects from operations and airport activities at Logan Airport are discussed within the applicable technical chapter(s), Chapter 2, *Activity Levels*, Chapter 3, *Airport Planning,* Chapter 4, *Regional Transportation*, Chapter 5, *Ground Access to and from Logan Airport*, Chapter 6, *Noise Abatement*, Chapter 7, *Air Quality/Emissions Reduction*, and Chapter 8, *Environmental Compliance and Management/Water Quality*.
A-5	Matthew Beaton, Secretary	Ground Access	The results of the Logan Airport Air Passenger Ground Access Survey and the Long-term Parking Management Plan should inform transportation planning and strategies to achieve the HOV mode share goal.	The *2017 ESPR* includes the results from the 2016 Logan Airport Air Passenger Ground Access Survey and includes the most recent Long-Term Parking Management Plan in Chapter 5, *Ground Access to and from Logan Airport*. Since the late 1970s, the Logan Airport Air Passenger Ground Access Survey has been Massport's primary tool for understanding the changes in air passenger travel behavior, including ground access mode choices, travel patterns, and market characteristics. The survey is a tool that assists Massport in evaluating the effectiveness of its transportation policies and services, and the impacts on the regional transportation system. The survey also shapes the direction of Massport's planning efforts to encourage Logan Airport travelers to use high-occupancy vehicle (HOV) and shared-ride modes instead of single-occupancy vehicle (SOV) modes. According to the 2016 Logan Airport Air Passenger Ground Access Survey, 30.5 percent of passengers use HOV modes to travel to Logan Airport. Based on 2016 survey results, if parking was not an option for passengers who parked on-Airport, 77 percent of survey respondents indicated that they would use drop-off/pick-up modes (i.e., dropped off or picked up by private vehicles, taxi, transportation network companies (TNCs), such as Uber and Lyft, or black car/limousine service). Prior surveys of Logan Airport air passengers have consistently shown similar results. The results of the 2019 air passenger survey will be reported in the next EDR.
A-6	Matthew Beaton, Secretary	Distribution	The ESPR must include copies of all ESPR and EDR Certificates and a distribution list for the 2017 ESPR (indicating those receiving documents, CDs, or Notices of Availability).	The *2017 ESPR* provides copies of prior ESPR and EDR Certificates issued since 2011 in Appendix A, *MEPA Certificates and Responses to Comments*. The *2017 ESPR* includes a distribution list of all persons receiving hard-copies or Notices of Availability in Appendix D, *Distribution.*

Comment #	Author	Topic	Comment	Response
A-7	Matthew Beaton, Secretary	Content	Supporting technical appendices should be provided as necessary.	The *2017 ESPR* includes supporting technical appendices for activity levels, regional transportation, ground access, noise abatement, air quality, water quality, peak period pricing monitoring, and reduced/single engine taxiing. Massport continually seeks to improve the quality of the ESPRs and EDRs by providing clear and concise language in the body of the report, and providing the technical and supporting documentation as appendices.
A-8	Matthew Beaton, Secretary	Responses to Comments	The Response to Comments section should address all of the substantive comments on the 2016 EDR, and other Certificates for Logan Airport that reference EDR/ESPR documentation (e.g. Logan Airport Parking Project, Terminal E).	The *2017 ESPR* includes the specified content in Appendix B, *Comment Letters and Responses*. Twelve comment letters were received on the *2016 EDR*. Massport has provided responses to items within Massachusetts Environmental Policy Act (MEPA) jurisdiction for each comment letter. Massport has included direct responses and in some cases, refers readers to the technical chapter and/or appendix for additional information. In addition, Appendix A also includes the Secretary's Certificate on the Terminal E Modernization Project Environmental Notification Form (ENF), issued December 16, 2015, and Draft Environmental Assessment (EA)/Environmental Impact Report (EIR), issued September 16, 2016, which directs certain items to be addressed in the EDRs and ESPRs. Appendix A also includes the Certificate on the Notice of Project Change on the 2016 ESPR and EDR which specifies the scope for this *2017 ESPR*.
A-9	Matthew Beaton, Secretary	Responses to Comments	To ensure that the issues raised by commenters are addressed, the 2017 ESPR should include direct responses to comments to the extent that they are within MEPA jurisdiction.	The *2017 ESPR* includes the specified content in Appendix B, *Comment Letters and Responses*. Twelve comment letters were received on the *2016 EDR*. Massport has provided responses to issues within MEPA jurisdiction for each comment letter, a format that responds directly to each applicable comment.
A-10	Matthew Beaton, Secretary	Responses to Comments	I recommend that the Massport continue to use the format from the 2016 EDR. The Responses to Comments should not reference a section of the 2017 ESPR unless they are directly responsive to the comment.	The *2017 ESPR* follows the specified format of the *2016 EDR*, Responses to Comments. Responses do not reference a section or appendix of the *2017 ESPR* unless the information in that section is directly responding to the comment.
A-11	Matthew Beaton, Secretary	Responses to Comments	Common themes that should be addressed throughout the ESPR and in the Responses to Comments include noise (modeling of noise contours and noise abatement) and emissions reduction issues.	The *2017 ESPR* provides information on noise modeling, noise contours, noise abatement, traffic, and air quality in Chapter 6, *Noise Abatement* and Chapter 7, *Air Quality/Emissions Reduction*, and responds to comments on these topics.
A-12	Matthew Beaton, Secretary	Responses to Comments	The 2017 ESPR should include sufficient information to address comments on traffic, air quality and public health which are common concerns of commenters.	The *2017 ESPR*, includes specific responses to comments with references to technical chapters and/or appendices for additional information that is found in the following chapters: Chapter 5, *Ground Access to and from Logan Airport*, Chapter 6, *Noise Abatement*, Chapter 7, *Air Quality/Emissions Reduction*, and Chapter 8, *Environmental Compliance and Management/Water Quality*. The *2017 ESPR*, Appendices A and B also include technical information in direct responses to commenters on traffic, air quality, and public health, when applicable.
A-13	Matthew Beaton, Secretary	Activity Levels, Environmental Impacts	The ESPR should describe how Massport will achieve long-standing goals to reduce overall operating and environmental impacts at the airport as passengers and, in particular, international passengers increase.	The *2017 ESPR* describes Massport's efforts to achieve long-standing goals and initiatives to reduce the environmental impacts from airport operations, as passenger activity, particularly international passenger levels increase. The local and regional economic growth is the primary driver for the continued increase in passenger demand and activity levels at Logan Airport; the region's prominence in higher-education institutions, technological industries, and regional tourism contribute to the increase in annual passengers. A comparison of 2017 operations and passenger activity levels to historical activity levels is also included in Chapter 2, *Activity Levels*. The *2017 ESPR* includes a discussion of beneficial measures and mitigation efforts in Chapter 9, *Environmentally Beneficial Measures and Project Mitigation Tracking*.

Comment #	Author	Topic	Comment	Response
A-14	Matthew Beaton, Secretary	Activity Levels, Environmental Impacts	Discussion of passenger and activity levels and planning/mitigation to address impacts of that growth, in particular air and noise emissions, should be a significant emphasis of the ESPR.	The key difference between EDR and ESPR documents is that the ESPR provides future forecasts for passenger volume, aircraft operations and fleet mix, and, based on those forecasts, assesses future environmental conditions. The results of these analyses are included in the *2017 ESPR* along with a comparison of 2017 operations to historic trends and future forecasts. Boston's prominence in technical and higher education industries coupled with substantial local and regional economic growth, have been key drivers in the passenger and operational increases. The *2017 ESPR* presents the forecasts for passenger and operations through the Future Planning Horizon (the next 10 to 15 years), and assesses the potential environmental impacts associated with the 50 million annual passenger forecast. The effect of anticipated future aircraft operations and passenger activity levels are discussed in the applicable technical chapter, Chapter 2, *Activity Levels* , Chapter 5, *Ground Access to and From Logan Airport* , Chapter 6, *Noise Abatement* , and Chapter 7, *Air Quality/Emissions Reduction* .
A-15	Matthew Beaton, Secretary	Activity Levels	The 2017 ESPR should report on: • Aircraft operations, including fleet mix and scheduled airline services at Logan Airport; • Domestic and international passenger activity levels; • Cargo and mail volumes; • Comparison of 2017 operations and passenger activity levels to 2016 activity levels; and • National aviation trends compared to Logan Airport trends.	Chapter 2, *Activity Levels,* reports on current and historical aircraft operations, passenger activity levels, cargo and mail volumes, and national aviation trends. A comparison of 2017 operations and passenger activity levels to historical activity levels is also included in Chapter 2, *Activity Levels* . This ESPR reports trends in annual passenger activity levels from 1990 through 2017; passenger volumes have trended upward since 1990, from 26.5 million passengers in 1990 to 38.4 million passengers in 2017. Aircraft operations have trended downward since 1990, from a peak of 507,499 operations in 1998 to 401,371 operations in 2017. Air cargo volumes increased at Logan Airport totaling 708 million pounds in 2017, compared to 640 million pounds in 2016.
A-16	Matthew Beaton, Secretary	Activity Levels	The 2017 ESPR should update the Logan Airport long-term passenger forecast to reflect growth trends at Logan Airport and revised expectations for the local/national/international economy.	The key difference between EDR and ESPR documents is that the ESPR provides future forecasts for airport activity levels and environmental conditions. The forecast analysis takes into account growth trends at Logan Airport and considers a Future Planning Horizon: the next 10 to 15 years. This information is included in Chapter 2, *Activity Levels* . The state of the local and regional economic growth is also discussed in Chapter 2, *Activity Levels,* as well as Chapter 4, *Regional Transportation* . The local and regional economic growth is the primary driver for the continued increase in passenger demand and activity levels at Logan Airport; the region's prominence for higher-education, technological industries, and regional tourism also contribute to the increase in annual passengers. Overall, passenger activity levels are expected to increase to approximately 50 million annual air passengers in the next 10 to 15 years.
A-17	Matthew Beaton, Secretary	Activity Levels/ Forecast	Planning and impact sections will be based on forecasting for the next five years through 2035. It should address methodologies and assumptions used in the analysis, including anticipated changes to fleet mix changes and other trends in the aviation industry.	The *2017 ESPR* includes an update to passenger activity and aircraft operations forecasts and describes the assumptions and methodologies used in the modeling. Consideration is given to local and national economic trends, anticipated aircraft fleet mix, and technological changes. See Chapter 2, *Activity Levels* and Appendix E, *Activity Levels* for additional information.
A-18	Matthew Beaton, Secretary	Activity Levels/ Forecast	It [the 2017 ESPR] should also provide: • Updated forecasts for passenger volume, aircraft operations, and fleet mix; • A comparison of 2017 operations to historic trends and 2035 forecasts; and • A comparison of forecast activity levels to Massport forecasts from previous ESPRs, FAA forecasts and the U.S. aviation industry.	Logan Airport EDRs provide a snapshot of current conditions and compares these conditions to past trends; while ESPRs also provide future forecasts for airport activity levels and estimates anticipated environmental conditions. The results of these analyses are included in this *2017 ESPR* , updated future forecasts for passenger volume, aircraft operations, and fleet mix are provided in Chapter 2, *Activity Levels* , along with a comparison of 2017 operations to historic trends and future forecasts.

Comment #	Author	Topic	Comment	Response
A-19	Matthew Beaton, Secretary	Sustainability	Progress towards achieving these [sustainability] goals was addressed in the 2016 EDR. The 2017 ESPR should update progress on these goals.	The *2017 ESPR* includes updates on progress towards meeting Massport's sustainability goals. For example, the continued reporting of greenhouse gas (GHG) emissions from aircraft, ground service equipment (GSE), and motor vehicles at Logan Airport, and energy use, energy components, and emissions data from Massport buildings. The *2017 ESPR* includes the results of the 2017 GHG emissions inventory, with a comparison to the results reported in the *2016 EDR*. A status report on Massport's sustainability program and recent activities are provided in Chapter 1, *Introduction/Executive Summary*.
A-20	Matthew Beaton, Secretary	Airport Planning	Consistent with EO 569, the Massachusetts State Hazard Mitigation and Climate Adaptation Plan and the Massachusetts Energy Plan will be released in September. The ESPR should address the project's consistency with these plans.	Massport is a national leader in preparing its infrastructure and facilities for anticipated changes in climate and other natural and man-made threats. Partly in response to Super Storm Sandy, Massport developed a comprehensive resiliency program to identify critical infrastructure and to enhance its resiliency. Massport's Resiliency Program has become an integrated part of its business strategy and operations. For over a decade, Massport has in place a robust sustainability program that addresses all aspects of planning, design, and operations at its facilities. As reported in the *Logan Airport 2018 Annual Sustainability and Resiliency Report*, approximately 60 percent of critical assets (electrical power, diesel fuel pumping stations, telecommunications systems, and public safety) have been protected from storm surge flooding via relocation, and/or raising in elevation. Massport's sustainability program includes air quality, ground access, noise, water quality, natural resources, community, and economic considerations. See https://www.massport.com/media/2774/massport-annual-sustainability-and-resiliency-report-2018_lr.pdf for an update on the progress made on sustainability and resiliency efforts.
A-21	Matthew Beaton, Secretary	GHG Emissions	The 2017 ESPR should incorporate GHG emissions reporting consistent with that provided in the 2016 EDR which was normalized to support effective review and analysis.	The *2017 ESPR* GHG assessment characterizes emissions by source, category, and scope in Chapter 7, *Air Quality/Emissions Reduction.* The 2017 GHG emissions inventory is included in Appendix I, *Air Quality/Emissions Reduction.* Massport is consistently working to reduce GHG emissions from operations on and off-site at Logan Airport. Consistent with the *2016 EDR*, this *2017 ESPR* normalizes evaluations of GHGs by passengers and building area considering: GHG emissions (Scopes 1 and 2) per passenger, GHG emissions by building square footage, and building energy use intensity. Normalizing the data by number of passengers and square feet shows that Logan Airport's energy efficiency has increased over time. The 2017 GHG emissions inventory is included in Appendix I, *Air Quality/Emissions Reduction.* Massport is consistently working to reduce GHG emissions from operations on and off-site at Logan Airport. The *2017 ESPR* discusses efforts to manage and improve traffic conditions and ground access to Logan Airport in Chapter 5, *Ground Access to and from Logan Airport*. Massport is committed to increasing HOV mode share and has a comprehensive, multi-pronged strategy to enhance HOV ridership, thereby reducing GHG emissions and vehicle miles traveled (VMT). The *2017 ESPR* GHG assessment characterizes emissions by source, category, and scope in Chapter 7, *Air Quality/Emissions Reduction.* The 2017 GHG emissions inventory is included in Appendix I, *Air Quality/Emissions Reduction.* Massport is consistently working to reduce GHG emissions from operations on and off-site at Logan Airport.
A-22	Matthew Beaton, Secretary	GHG Emissions/ Data Reporting	In addition, Massport should ensure that only conditioned (heated and cooled, enclosed buildings) building areas are included in energy use and emission intensity calculations, report input energy components (oil, gas, electricity) and central plant data and clarify how renewables are accounted in the analysis.	The *2017 ESPR* GHG assessment characterizes emissions by source, category, and scope in Chapter 7, *Air Quality/Emissions Reduction.* The 2017 GHG emissions inventory is included in Appendix I, *Air Quality/Emissions Reduction.* Scope 1 GHG emissions from stationary sources include heating fuel consumed for buildings, including the Central Heating and Cooling Plant, emergency generators, snow melters, and the live fire training facility. At this time, Massport reports all electricity consumption in aggregate (including all buildings and operations) as Scope 2 GHG emissions. Estimated GHG emissions are reported for GSE, Massport shuttle bus, Massport express bus, and on-Airport roadways emission source categories (shown in Table 7-12).

Comment #	Author	Topic	Comment	Response
A-23	Matthew Beaton, Secretary	GHG Emissions/ Data Reporting	Massport should consult with the MEPA Office and the Department of Energy Resources (DOER) regarding presentation of GHG data in the 2017 ESPR and subsequent EDRs.	In the *2017 ESPR* , Massport will report and present GHG data consistent with the methods provided by the MEPA Office and the Department of Energy Resources (DOER). Although the *2017 ESPR* is not subject to the MEPA GHG Emissions Policy and Protocol, Massport has reported and prepared the GHG inventory using MEPA's GHG Policy and Protocol since the *2007 EDR.* The emission source categories analyzed in the *2017 ESPR* are intended to satisfy MEPA's requirements for direct and indirect mobile and stationary source emissions. Information regarding the GHG assessment and reporting methods are provided in Chapter 7, *Air Quality/Emissions Reduction.*
A-24	Matthew Beaton, Secretary	GHG Emissions	The 2017 ESPR GHG emissions should continue to be quantified for aircraft, GSE, motor vehicles and stationary sources using emission factors and methodologies outlined in the *Greenhouse Gas Emissions Policy and Protocol* issued by EEA and the Transportation Research Board's *Guidebook on Preparing Airport Greenhouse Gas Emissions Inventories* (Airport Cooperative Research Program (ACRP) Report 11, Project 02-06). The results of the 2017 GHG emissions inventory should be compared to the 2016 results.	The *2017 ESPR* reports on GHG emissions at Logan Airport, and the GHG inventory includes aircraft, GSE, Massport fleet vehicles, and stationary sources. The inventory uses a methodology consistent with the MEPA GHG Emissions Policy and Protocol and the Transportation Research Board (TRB) Airport Cooperative Research Program (ACRP) GHG methodology guidance. Massport has voluntarily prepared an inventory of GHG emissions both directly and indirectly associated with Logan Airport since the *2007 EDR* . The ESPR provides information on the GHG assessment in Chapter 7, *Air Quality/Emissions Reduction* and Appendix I, *Air Quality/Emissions Reduction* .
A-25	Matthew Beaton, Secretary	Airport Planning, Resiliency	The 2017 ESPR should provide a summary of the DIRP Study and identify which recommendations Massport will implement in the short term and long term.	The *2017 ESPR* provides a summary of the Disaster and Infrastructure Resiliency Planning (DIRP) Study as well as other Massport resiliency planning efforts, including the 2014 Flood Proofing Design Guidelines (updated in 2016), and the Flood Operations Plans for Logan Airport in 2015. Massport also reports on the progress of its resiliency efforts in the Annual Sustainability and Resiliency Report (published in April 2018). As reported in the most recent Annual Sustainability and Resiliency Report, over 60 percent of critical assets such as electrical power facilities, diesel fuel pumping stations, telecommunications systems, and police and fire public safety buildings have been enhanced with resiliency measures. The 2018 Sustainability and Resiliency Report is available on Massport's website at http://www.massport.com/massport/business/capital-improvements/sustainability/.
A-26	Matthew Beaton, Secretary	Content	The 2016 EDR identifies the status of mitigation commitments for specific Massport and tenant projects at Logan Airport that have undergone MEPA review. The 2017 ESPR will address cumulative, Airport-wide impacts.	The *2017 ESPR* includes the specified content in Chapter 9, *Environmentally Beneficial Measures and Project Mitigation Tracking.* The ESPR continues to report on cumulative, Airport-wide environmental impacts on air quality, noise, and water quality in the applicable chapters. The chapter also provides a summary of beneficial measures implemented by Massport that are not tied to project-specific mitigation.
A-27	Matthew Beaton, Secretary	Mitigation	The 2017 ESPR should update the status of mitigation commitments for recent projects such as the Terminal E Modernization Project and the Logan Airport Parking Project as well as projects previously included in the EDRs.	The *2017 ESPR* includes the specified content in Chapter 9, *Environmentally Beneficial Measures and Project Mitigation Tracking.* The ESPR reports on the status of specific Massport and tenant projects at Logan Airport, including the Terminal E Modernization Project (in design) and Logan Airport Parking Project (in permitting).
A-28	Matthew Beaton, Secretary	Airport Planning	The 2017 ESPR should continue to assess planning strategies for improving Logan Airport's operations and services in a safe, secure, more efficient, and environmentally sensitive manner. As owner and operator of Logan Airport, Massport must accommodate and guide tenant development.	Massport has identified priority planning projects and initiatives to accommodate increased demand in international and domestic travel, enhance ground access to and from Logan Airport, and improve on-Airport roadways and parking. The *2017 ESPR* provides information on planning strategies for improving Logan Airport's operations and services in a safe, secure, and more efficient and environmentally sensitive manner in Chapter 3, *Airport Planning.* The ESPR also describes Airport-wide projects and planning concepts. Massport works closely with tenants to guide tenant development while accommodating tenants needs.

Comment #	Author	Topic	Comment	Response
A-29	Matthew Beaton, Secretary	Airport Planning	The ESPR should describe the status of planning initiatives for the following areas: • Roadways and Airport Parking; • Terminal Area; • Airside Area; • Service and Cargo Areas; and • Airport Buffers and Landscaping.	The *2017 ESPR* provides information on planning strategies for improving Logan Airport's operations and services in a safe, secure, and more efficient and environmentally sensitive manner in Chapter 3, *Airport Planning.* The ESPR describes short- and long-term planning initiatives for Logan Airport's terminal areas, service areas, buffer and open space areas, parking areas, and airside areas under the new forecasts of passenger activity through the future planning horizon. The *2017 ESPR* discusses the future of Logan Airport under the context of the updated forecasted passenger activity levels and aircraft operation levels in Chapter 2, *Activity Levels.*
A-30	Matthew Beaton, Secretary	Airport Planning	The 2017 ESPR should also indicate the status of long-range planning activities, including the status of public works projects implemented by other agencies within the boundaries of Logan Airport.	The *2017 ESPR* lists short and long-term planning projects, including those that have been recently completed, are underway, and are in planning stages, in Chapter 3, *Airport Planning,* Table 3-1.
A-31	Matthew Beaton, Secretary	Ground Access	The ESPR should identify the status and assess effectiveness of ground access changes, including roadway and parking projects, that consolidate and direct airport-related traffic to centralized locations and minimize airport-related traffic on streets in adjacent neighborhoods.	The *2017 ESPR* reviews the current and historical traffic and ground access trends, and provides information on projects at Logan Airport to minimize airport-related traffic. Massport is committed to increasing HOV mode share and has a comprehensive, multi-pronged strategy to enhance HOV ridership. Ridership on Logan Express increased by about 1 percent while public transportation decreased by about 2 percent in 2017 (Table 5-8). The increase in Logan Express ridership is largely attributed to the increase in employee usage (7 percent), as the total number of air passengers using Logan Express decreased (2 percent) as compared to 2016. Massport will continue its strategy to provide a broad range of HOV, transit, and shared-ride options for travel to and from Logan Airport and to minimize vehicle trips, by providing convenient transit, shuttle, bike, and pedestrian connections to the Airport. The strategy also aims to provide on-Airport parking for passengers choosing to drive or persons who have limited HOV options. For more information, see Chapter 5, *Ground Access to and from Logan Airport.*
A-32	Matthew Beaton, Secretary	Regional Transportation	The 2017 ESPR should report on: <u>Regional Airports</u> • 2017 regional airport operations, passenger activity levels, and schedule data within an historical context; • Status of plans and new improvements as provided by the regional airport authorities; • Role of the Worcester Regional Airport and Hanscom Field in the regional aviation system and Massport's efforts to promote these airports; and • Ground access improvements at Massachusetts Regional Airports. <u>Regional Transportation System</u> • Massport's role in managing the regional transportation facilities within MassDOT; • Massport's cooperation with other transportation agencies to promote efficient regional highway and transit operations; and • Report on metropolitan and regional rail initiatives and ridership.	Logan Airport is one of three airports owned and operated by Massport, and is the primary international and domestic airport operating within a larger network of New England Regional Airports. The *2017 ESPR* provides information on passenger and aircraft activity levels at New England regional airports, including Worcester Regional Airport and Hanscom Field, in Chapter 4, *Regional Transportation.* Massport recognizes the continued importance of coordinated airport development through the New England region, and the *2017 ESPR* identifies significant airport improvements that are planned and under construction at regional airports. Massport is continually working to increase HOV-ridership and public transportation options to Massport facilities. By working with and supporting a balanced regional transportation network Massport is helping reduce reliance on Logan Airport and provide travelers to and from New England a greater range of reliable multimodal transportation alternatives. The *2017 ESPR* provides updates on the regional transportation network in Chapter 4, *Regional Transportation.* In 2017, Massport invested $4.3 million in airfield, terminal, and equipment improvements at Hanscom Field. Massport completed construction of Worcester Regional Airport's Category (CAT) III Instrument Landing System in March 2018, to elevate operational conditions and enhance safety to a level equal to that of all other commercial airports in New England. This project significantly improves Worcester Regional Airport's all-weather reliability, a long-standing impediment to greater use of this airport. In 2017, MassDOT released the revised Massachusetts State Freight Plan to look at near-term and long-term vision for the freight system in Massachusetts, this plan was approved by the Federal Highway Administration in 2017. System-wide Amtrak ridership levels were 31.4 million customer trips in fiscal year 2017, and the Northeast Corridor was up about 1 percent from 2016 ridership levels.

Comment #	Author	Topic	Comment	Response
A-33	Matthew Beaton, Secretary	Ground Access	The 2016 EDR contained an outline of the proposed ground access study required by the Parking Freeze amendments. The results recommendations of this study will be presented in the 2017 ESPR.	The specific content is included in the *2017 ESPR* in Chapter 5, *Ground Access to and from Logan Airport* and Appendix G, *Ground Access.* The 2017 Logan Airport Parking Space Inventory Report (or Parking Freeze Report) was initially submitted to the Massachusetts Department of Environmental Protection in March 2017, a revised submission was submitted October 2017, both are included in Appendix G, *Ground Access.* Massport has a multi-part strategy to efficiently manage parking supply, pricing, and operations at both Logan Airport and Massport controlled off-Airport properties, planning elements and progress to date are reported in Table 5-6. The ground access studies required by the Parking Freeze Amendments are still ongoing and findings will be reported in the next EDR. These include analyzing the feasibility of potential services and improvements to HOVs, possible pricing strategies for different modes, and potential operational measures to further reduce drop-off/pick-up modes.
A-34	Matthew Beaton, Secretary	Ground Access	Beginning with the 2017 ESPR, Massport will introduce a new definition for high occupancy vehicle (HOV) modes that will provide more accuracy.	In this *2017 ESPR* , Massport presents a new definition of HOV, updating the definition to include the increased knowledge and data from the rapidly changing transportation landscape since the emergence of TNCs, such as Uber and Lyft, and the impacts on the ground access network. Under the updated definition, taxis, black car limousines, and TNCs that carry two or more air passengers per vehicle will be defined as HOV.
A-35	Matthew Beaton, Secretary	Ground Access	The 2017 ESPR should report on 2017 ground access conditions at the airport and provide a comparison to 2016 for the following: • Description of compliance with Logan Airport Parking Freeze; • High-occupancy vehicle (HOV) ridership (including Blue Line, Silver Line, Water Transportation, and Logan Express); • Logan Airport Employee Transportation Management Association (Logan TMA) services; • Logan Airport gateway volumes; • On-airport traffic volumes; • On-airport vehicle miles traveled (VMT); • Parking demand and management (including rates and duration statistics); • Status of long-range ground access management strategy planning; • Results of the 2016 Logan Airport Air Passenger Ground Access Survey; and, • Status of proposed connector to the Airport Station associated with the planned Terminal E Modernization Project.	This ESPR includes the specified content and compares 2017 findings to those of 2016. The *2017 ESPR* provides information on current and historical ground access conditions in Chapter 5, *Ground Access to and from Logan Airport.* The ESPR discusses critical aspects of ground access conditions at Logan Airport, including HOV modes and ridership, Logan Airport Employee TMA services, traffic volumes and VMT, parking conditions, ground access strategy, and the status of current projects, including the Terminal E Modernization Project. Improving access from the MBTA Blue Line Airport Station and all the terminals (including Terminal E) is a major study currently being undertaken by Massport with the goal of reducing on-Airport congestion and improving passenger convenience. Progress on this effort is reported in this ESPR and subsequent EDRs will provide updates on its status as it progresses.
A-36	Matthew Beaton, Secretary	Ground Access	The chapter should present a discussion of analytical methodologies and assumptions for the planning horizon year (2035) for traffic volumes, on-airport VMT and parking demand.	The *2017 ESPR* discusses the specified content in Chapter 5, *Ground Access to and from Logan Airport* and Appendix G, *Ground Access.* The predictions for VMT and parking demand are discussed under the future projections of passenger activity in Chapter 5, *Ground Access to and from Logan Airport.* Additional data regarding forecasted traffic volumes and parking demand are included in Table G-8 in Appendix G, *Ground Access* .

Comment #	Author	Topic	Comment	Response
A-37	Matthew Beaton, Secretary	Ground Access	The 2017 ESPR should address the following topics: • Target HOV mode share and incentives; • Non-Airport through-traffic; • Cooperation with other transportation agencies to increase transit ridership to and from Logan Airport via the Blue Line, Silver Line, Water Transportation, and Logan Express; • Report on efforts to increase capacity and use of Logan Express; • Progress on enhancing water transportation to and from Logan Airport; • Results and recommendations of the ground access study Long-term Parking Management Plan required by the Parking Freeze amendments; and • Strategies for enhancing services and increasing employee membership in the Logan Airport TMA.	This ESPR includes the specified content. The *2017 ESPR* discusses efforts to manage and improve traffic conditions and ground access to Logan Airport in Chapter 5, *Ground Access to and from Logan Airport.* Massport is committed to increasing HOV mode share and has a comprehensive, multi-pronged strategy to enhance HOV ridership. Ridership on public transportation decreased minimally for public transportation, approximately 2 percent, and increased slightly for Logan Express Ridership (approximately 1 percent). Table 5-3 provides the yearly ridership data for public transportation, Logan Express, and water transportation services. Massport will continue its strategy to provide a broad range of HOV, transit, and shared-ride options for travel to and from Logan Airport and to minimize vehicle trips, by providing convenient transit, shuttle, bike, and pedestrian connections to the Airport. The strategy also aims to provide on-Airport parking for passengers choosing to drive or who have limited HOV options. The latest air passenger ground-survey revealed air passengers using HOV/shared-ride modes equaled 30.5 percent. The ground access studies required by the Parking Freeze Amendments are still ongoing and findings will be reported in the next EDR. With its updated definition for HOV, Massport has committed to a goal of 35.5 percent HOV by 2022 and 40 percent by 2027.
A-38	Matthew Beaton, Secretary	Noise	The 2017 ESPR must provide strategies to address noise impacts which are expressed in numerous comments received on the 2016 EDR.	Chapter 6, *Noise Abatement* describes Massport's comprehensive noise abatement program and outlines efforts related to sound insulation of residences and schools, responses to noise complaints, and efforts to collaborate with the Federal Aviation Administration (FAA) regarding flight tracks and airlines on specific operational and technological enhancements.
A-39	Matthew Beaton, Secretary	Noise	The 2017 ESPR should provide an overview of the environmental regulatory framework affecting aircraft noise, the changes in aircraft noise, and the updates in noise modeling.	The *2017 ESPR* provides an overview of the regulatory framework for aircraft noise, the noise modeling methodology, and the resulting changes in modeled aircraft noise in Chapter 6, *Noise Abatement.* As with the *2016 EDR,* this ESPR models noise conditions using the FAA-required Aviation Environmental Design Tool (AEDT) model.
A-40	Matthew Beaton, Secretary	Noise	The chapter should report on 2017 conditions and provide a comparison to 2016 for the following: • Fleet Mix, including Stage II, Recertified Stage III, newly manufactured Stage III, and qualifying Stage IV aircraft; • Nighttime operations; • Runway utilization (report on aircraft and airline adherence with runway utilization goals); • Preferential runway advisory system (PRAS) tracking; and • Flight tracks.	The *2017 ESPR* Chapter 6, *Noise Abatement* reports on the information outlined in the Secretary's comment. All jet aircraft currently operating at Logan Airport are categorized by the FAA as Stage 3 or Stage 4. Stage 5 aircraft certification will begin in 2017, however 18 percent of the current jet fleet already meets Stage 5 standards. Nighttime operations increased from 55,497 operations in 2016 to 61,154 operations in 2017. Runway utilization remained relatively stable between 2015 and 2016. The *2017 ESPR* shows RNAV flight tracks for air carrier, regional jet, and non-jet arrivals and departures throughout 2017. For more information regarding 2017 noise data, please reference Chapter 6, *Noise Abatement* .
A-41	Matthew Beaton, Secretary	Noise	The 2017 ESPR should report on the following: • Changes in annual noise contours and noise-impacted population; • Measured versus modeled noise values, including reasons for differences and any improvements attributable to the models deployed; • Cumulative Noise Index (CNI); • Times-Above for 65, 75, and 85 dBA threshold values/Dwell and Persistence of noise levels; and • Flight track monitoring noise reports.	The *2017 ESPR* includes the specified content in Chapter 6, *Noise Abatement.* Massport has modeled 2017 noise conditions using AEDT. Chapter 6, *Noise Abatement* compares the 2017 day-night average sound level (DNL) contours to the 2016 DNL contours. As stated in the *2016 EDR,* Massport used the FAA-required AEDT model in place of the outdated Integrated Noise Model (INM). The ESPR describes changes attributable to both operations and modeling. The ESPR reports on CNI, Time Above, and Dwell and Persistence in Chapter 6, *Noise Abatement.* Appendix H, *Noise Abatement* includes the flight track monitoring reports for 2017.

Comment #	Author	Topic	Comment	Response
A-42	Matthew Beaton, Secretary	Noise	The 2017 ESPR should also report on noise abatement efforts, results from Boston Logan Airport Noise Study (BLANS) study, and provide an update on the noise and operations monitoring system.	The *2017 ESPR* includes the specified content in Chapter 6, *Noise Abatement.* The Boston Logan Airport Noise Study, or BLANS, has been ongoing since 2008. This study has been an open forum for noise discussions. The FAA-sponsored BLANS program recently concluded and a final report was published in 2017. The *2017 ESPR* reviews the past and current coordination between Massport and the FAA regarding RNAV procedures. The ESPR includes an update on noise abatement efforts and Massport's noise and operations monitoring system.
A-43	Matthew Beaton, Secretary	Air Quality / Emissions Reductions	The 2017 ESPR should contain an overview of the environmental regulatory framework affecting aircraft emissions, changes in aircraft emissions, and the changes in air quality modeling.	The *2017 ESPR* includes the specified content in Chapter 7, *Air Quality/Emissions Reduction.* The ESPR provides an overview of the regulatory framework for aircraft emissions, the emissions modeling methodology, and the resulting changes in modeled aircraft emissions. The chapter includes information on the Clean Air Act, the National Ambient Air Quality Standards, and Massachusetts state laws governing air quality. The ESPR includes an expanded section on ultrafine particles (UFPs) and a new section on Black Carbon. Massport will continue to track the regulatory status of these pollutants.
A-44	Matthew Beaton, Secretary	Air Quality / Emissions Reductions	The 2017 ESPR should also provide discussion on progress on the national and international levels to decrease air emissions.	Chapter 7, *Air Quality/Emissions Reduction* includes a discussion of Massport's progress towards decreasing air emissions. For example, initiatives are underway within the U.S. and internationally to reduce aviation's contribution to global GHG emissions. Such efforts include new aircraft technologies to reduce emissions and improve fuel efficiency, renewable alternative fuels with lower carbon footprints, more efficient air traffic management, market-based measures, and environmental regulations including an aircraft carbon dioxide (CO_2) standard. A summary of statewide, national and international initiatives is provided in Chapter 7, *Air Quality/Emissions Reduction.*
A-45	Matthew Beaton, Secretary	Air Quality / Emissions Reductions	Massport should continue to use the FAA's AEDT model for air emissions modeling as was presented in the 2016 EDR.	For this *2017 ESPR,* the FAA's next-generation software, AEDT was used to determine aircraft emissions. These results are reported on and discussed in Chapter 7, *Air Quality/Emissions Reduction.*
A-46	Matthew Beaton, Secretary	Air Quality / Emissions Reductions	The EPA Motor Vehicle Emission Simulator (MOVES) tool will continue to be used to assess vehicular emissions on airport roadways. The 2017 ESPR should include a mobile sources emissions inventory for CO, NOx, VOCs, and PMs.	In the *2017 ESPR*, Massport continued to use the U.S. Environmental Protection Agency (EPA) Motor Vehicle Emissions Simulator (MOVES) tool to assess and report vehicular emissions on airport roadways. The specific content is reported and discussed in Chapter 7, *Air Quality/Emissions Reduction* and Appendix I, *Air Quality/Emissions Reduction.* The *2017 ESPR* includes an emissions inventory for carbon monoxide (CO), oxides of nitrogen (NOx), volatile organic compounds (VOCs), and particulate matter (PM) in Chapter 7, *Air Quality/Emissions Reduction.*
A-47	Matthew Beaton, Secretary	Air Quality / Emissions Reductions	It should also report on Massport and tenant alternative fuel vehicle programs and the status of Logan Airport air quality studies undertaken by Massport or others, as available.	The *2017 ESPR* includes the specified content in Chapter 7, *Air Quality/Emissions Reduction.* Massport now operates 92 vehicles powered by compressed natural gas (CNG), propane, E85 flex fuel, or operates hybrids powered by gasoline or diesel. The ESPR reports on Massport's air quality emissions reduction goals and their status in 2017. There are a total of 115 electric ground service equipment (eGSE) in service at Logan Airport. As part of its long-range emission reduction strategy, Massport is working with the airlines to replace 25 percent of all gas- and diesel-powered GSE with electric alternatives by 2022, and 100 percent by the end of 2027 (as commercially available).
A-48	Matthew Beaton, Secretary	Air Quality / Emissions Reductions	The ESPR should include updated information regarding potential regulation, research and monitoring of UFPs.	As noted by the Secretary, at this time, there are no state or federal air quality standards for outdoor levels of UFPs. Massport is actively tracking the research and regulatory status of this pollutant and will comply with future UFP standards if promulgated by EPA. The *2017 ESPR* provides information on initiatives to reduce diesel and other GHG emissions, and provides an expanded section on UFPs in Chapter 7, *Air Quality/Emissions Reduction.* Massport has also added a section that discusses Black Carbon in response to community interest. Massport will continue to track the research and regulatory status of this parameter.
A-49	Matthew Beaton, Secretary	Air Quality / Emissions Reductions	Massport should also provide an update on its efforts to encourage the use of single engine taxiing under safe conditions.	The *2017 ESPR* includes the specified content in Chapter 7, *Air Quality/Emissions Reduction.* Massport has included the 2017, 2018, and 2019 memoranda sent to the Logan Airport Airline Committee on reduced/single engine taxiing at Logan Airport in Appendix L, *Reduced/Single Engine Taxiing at Logan Airport Memoranda.*

Comment #	Author	Topic	Comment	Response
A-50	Matthew Beaton, Secretary	Air Quality / Emissions Reductions	In addition, the 2017 ESPR should provide an update on the feasibility of combined heat and power (CHP) use for Terminal E and updates to progress made in designing the energy systems for the facility.	The Terminal E Modernization Project is still in the design phase. The feasibility of CHP is being studied, and the energy systems to be deployed in the facility will be summarized in future EDR/ESPR filings.
A-51	Matthew Beaton, Secretary	Water Quality	The 2017 ESPR should identify any planned stormwater management improvements and report on the status of: • NPDES Permit and monitoring results for Logan outfalls and the Fire Training Facility; • Jet fuel usage and spills; • MCP activities; • Tank management; • Update on the environmental management plan; and • Fuel spill prevention.	The *2017 ESPR* includes an overview of the regulatory framework for stormwater management at Logan Airport, the National Pollutant Discharge Elimination System (NPDES) Permit and monitoring results, and records of hazardous material spills, tank management activities, and implementation of the Environmental Management System (EMS) in Chapter 8, *Environmental Compliance and Management/Water Quality* and Appendix J, *Environmental Compliance and Management/Water Quality*. Massport continues to sample outfalls and implement a Stormwater Pollution Prevention Plan (SWPPP) in accordance with the current NPDES Permit. In 2017, 100 percent of stormwater samples were in compliance with this permit. Massport complies with the Massachusetts Contingency Plan (MCP) by monitoring fuel spills and tracking the status of spill response actions, and implements the ISO 14001-certified EMS to control, monitor, and improve environmental compliance for underground and aboveground storage tanks, materials management, and other environmental compliance activities.

Secretary of the Executive Office of Energy and Environmental Affairs Certificate on the *Logan Airport 2016 EDR Notice of Project Change* and Massport's Responses to New Comments raised in the Certificate

This Page Intentionally Left Blank.

The Commonwealth of Massachusetts

Executive Office of Energy and Environmental Affairs
100 Cambridge Street, Suite 900
Boston, MA 02114

Charles D. Baker
GOVERNOR

Karyn E. Polito
LIEUTENANT GOVERNOR

Matthew A. Beaton
SECRETARY

Tel: (617) 626-1000
Fax: (617) 626-1181
http://www.mass.gov/envir

March 9, 2018

CERTIFICATE OF THE SECRETARY OF ENERGY AND ENVIRONMENTAL AFFAIRS
ON THE
NOTICE OF PROJECT CHANGE

PROJECT NAME	: 2016 Environmental Status and Planning Report (ESPR)/ Environmental Data Report (EDR)
PROJECT MUNICIPALITY	: Boston/Winthrop
PROJECT WATERSHED	: Boston Harbor
EOEA NUMBER	: 3247
PROJECT PROPONENT	: Massachusetts Port Authority
DATE NOTICED IN MONITOR	: February 7, 2018

Pursuant to the Massachusetts Environmental Policy Act (MEPA; M.G.L. c. 30, ss. 61-62I) and Section 11.10 of the MEPA regulations (301 CMR 11.00), I have reviewed the Notice of Project Change (NPC) and **hereby determine** that a Supplemental Environmental Impact Report (EIR) is not required.

The NPC consists of a request by the Massachusetts Port Authority (Massport) to shift the timing and sequence of the 2016 Environmental Status and Planning Report (ESPR) and 2017 Environmental Data Report (EDR). Massport has proposed this change because it is concerned that 2016 is not an appropriate baseline year from which to forecast long-term operational and environmental conditions. The NPC indicates that the concern is based changes associated with: (1) rapidly growing domestic and international passenger demand; (2) the formal introduction to Logan Airport of transportation network companies (TNC), such as Uber and Lyft, in early 2017; and (3) use of the Federal Aviation Administration's (FAA) Aviation Environmental Design Tool (AEDT) for noise and air quality modeling for 2016 reporting.

I am granting this request based on the following:

- Massport will submit a 2016 EDR in lieu of the ESPR.
- The 2016 EDR will supplement typical EDR data reporting with discussion of future passenger and activity levels, planning to address growth and strategies to minimize environmental impacts.
- The 2016 EDR will include a draft Scope for the 2017 ESPR and identify when the ESPR will be filed.

Logan Airport Environmental Review and Planning

The environmental review process for Logan Airport has been structured to occur on two levels: airport-wide and project-specific. The ESPR has evolved from a largely retrospective status report on airport operations to a broader analysis that also provides a prospective assessment of long-range plans. It has thus become, consistent with the objectives of the MEPA regulations, part of the long-range planning process for Massport. The ESPR provides a "big picture" analysis of the environmental impacts associated with current and projected activity levels, and presents a comprehensive strategy to minimize impacts.

The ESPR is generally updated on a five-year basis. EDRs (formerly referred to as Annual Updates) are filed annually in the years between ESPRs. EDRs consist of a status report and annual reporting on activity levels and associated environmental impacts at Logan Airport. ESPR's are also supplemented by (and ultimately incorporate) project-specific Environmental Impact Reports (EIR) that provide detailed analyses and mitigation commitments for proposed projects. The sequence and timing for submitting ESPRs and EDRs has been adjusted previously based on consultation between Massport and the Executive Office of Energy and Environmental Affairs (EEA). Most recently, with EEA approval, Massport deferred submittal of the 2011 ESPR by two years based on the regional and national economic downturn experienced in the mid- to late-2000s.

Through these reports, Logan Airport is subject to comprehensive and regular MEPA review, including opportunities for public comment on cumulative impacts. This regular updating and reporting on planning and cumulative impacts is unique among State Agencies. It reflects the challenge and complexity of managing and modernizing Logan Airport within a dense, urban area. It recognizes that the proximity of communities to the Airport warrants an enhanced level of public engagement and a concerted, long-term effort to minimize and mitigate impacts.

On February 17, 2017, I issued a Certificate on the 2015 EDR which contained a review of the 2015 EDR and Scope for the 2016 ESPR. This Certificate on the NPC is informed by and includes references to the 2015 EDR, data and conclusions. This Certificate supplements, but does not replace, the 2015 EDR Certificate. The Scope for the 2017 EDR will be revised based on the review of the 2016 EDR.

In 2015, Logan Airport served an all-time high of 33.4 million passengers, exceeding the 2014 historic peak. A significant portion of growth in passengers is driven by an increase in demand for international air service. Massport has responded to this demand by providing new service to international destinations and expanding service to existing destinations. As passenger levels have increased, aircraft operations remain significantly below the peak of 507,449 operations experienced in 1998 when Logan Airport served 26.5 million passengers. The reduction of over 130,000 annual flight operations combined with transition towards newer and larger aircraft with improved environmental performance and operational efficiencies, have supported passenger growth while limiting environmental impacts.

The long-term trend is towards more efficient operations and significant reductions in overall environmental impacts. Although environmental impacts are significantly lower compared to 1998 when operations were highest, comparison of activity level and environmental impact data to 2014 and more recent EDRs identifies increases in noise exposure, air emissions and traffic. These increases were not forecast in the 2011 ESPR. The increases are associated with passenger growth, changes in flight patterns and changes in modeling of noise and air quality.

The most significant change since 2011 is the introduction by the FAA of changes to area navigation (RNAV) procedures. The RNAV program has been implemented throughout the country and its primary purpose is to increase safety and operational efficiency. The implementation of several of these procedures has resulted in concentrations of flight patterns over certain communities and significant increases in noise exposure.

The impact of the RNAV program was reflected in the many comment letters received during review of specific projects, including the Terminal E Modernization Project (EEA# 15434). Massport and the FAA signed a Memorandum of Understanding (MOU) in 2017 to frame a new process for analyzing opportunities to incrementally reduce noise through changes or amendments to Performance Based Navigation, including RNAV procedures.

Another significant change identified in the 2015 EDR was the introduction of AEDT for emissions and noise modeling. Based on its evaluation of the model, Massport requested that FAA approve development of specific adjustments to the AEDT model consistent with those developed for the Integrated Noise Model (INM). Based on this consultation, Massport deferred use of the AEDT. Projections in the 2016 EDR will be based on AEDT and will provide an opportunity to review and comment on the model and results prior to its use in the 2017 ESPR.

In addition, Logan Airport passenger ground access is changing rapidly with the use of TNCs for departures and arrivals at the Airport. Massport has been collecting TNC data since February 2017 when TNCs began picking up, in addition to dropping off, at Logan. The 2017 ESPR will include limited data from 2016 and a year of data for 2017.

The Scope for the 2016 EDR will include description and analysis of these changes which will influence results and projections and provide context for the 2017 ESPR. The deferment of the ESPR until 2019 will provide more meaningful data and will be employed to develop a more reliable baseline from which activity and impacts can be projected.

Scope for the 2016 EDR

General

The 2016 EDR should follow the general format of the 2015 EDR to provide an update on conditions at Logan Airport, including passenger and aircraft operation activity levels. It should include an Executive Summary and Introduction, similar to previous ESPRs and EDRs.

The 2016 EDR must include information on the environmental policies and planning that form the context of environmental reporting, technical studies, and environmental mitigation initiatives against which projects at Logan Airport can be evaluated. This should include identification of the cumulative effects of Logan Airport operations and activities, compared to previous years, as appropriate. It should report on status of Massport's proposed planning initiatives, projects, and mitigation measures. The results of the 2016 Logan Airport Air Passenger Ground Access Survey and the Long-term Parking Management Plan should be used in the 2016 EDR to inform transportation planning.

The technical studies should include reporting on and analysis of key indicators of airport activity levels, the regional transportation system, ground access, noise, air quality, environmental management, and project mitigation tracking. The 2016 EDR must also respond to those issues explicitly noted in this Certificate and the comments received on the 2015 EDR and noted in the February 17, 2017 Certificate.

A distribution list for the 2016 EDR (indicating those receiving documents, CDs, or Notices of Availability) should be provided in the document. This section must also include copies of all ESPR and EDR Certificates. Supporting technical appendices should be provided as necessary.

Response to Comments

The Response to Comments section should address all of the substantive comments on the 2015 EDR, and other Certificates for Logan Airport that reference EDR/ESPR documentation (e.g. Logan Airport Parking Project, Terminal E). To ensure that the issues raised by commenters are addressed, the 2016 EDR should include direct responses to comments to the extent that they are within MEPA jurisdiction. This directive is not intended to, and shall not be construed to, enlarge the scope of the 2016 EDR beyond what has been expressly identified in this Certificate. I recommend that the Massport continue to use the format from the 2015 EDR. The Responses to Comments should not reference a section of the 2016 EDR unless they are directly responsive to the comment. Common themes that should be addressed throughout the EDR and in the Responses to Comments include noise (modeling of noise contours and noise abatement) and emissions reduction issues. The 2016 EDR should include sufficient information to address comments on traffic, air quality and public health which are common concerns of commenters.

Activity Levels

Air traffic activity levels at Logan Airport are the basis for the evaluation of noise, air quality, and ground access conditions associated with the Airport. In this section, current activity levels at the Airport are compared to prior-year levels, and historical passenger and operations trends at Logan Airport dating back to 2000 which is the year Massport approved an Environmental Management Policy. The total number of air passengers increased by 5.7 percent to 33.4 million in 2015, compared to 31.6 million in 2014. As noted previously, the 2015 passenger level represents a record high for Logan Airport.

Passenger aircraft operations accounted for 91 percent of total aircraft operations in 2015. The total number of aircraft operations increased from 363,797 in 2014 to 372,930 in 2015, a 2.5-percent increase. This was preceded by a 0.7 percent increase from 2013 to 2014. Although operations are increasing compared to previous years, aircraft operations at Logan Airport remained well below the 487,996 operations in 2000 and the historical peak of 507,449 achieved in 1998. In 1998, Logan Airport served 26.5 million air passengers, compared to 33.4 million in 2015, which saw 134,519 fewer operations.

Air carrier efficiency continued to improve in 2015 as the average number of passengers per aircraft operation at Logan Airport grew from 87.0 in 2014 to 89.7 in 2015. This positive trend is indicative of the industry-wide shift toward higher aircraft load factors and an increase in the number of domestic and international destinations. Annual domestic passengers' activity levels increased from 26.5 million in 2014 to 27.8 million in 2015, a 4.8-percent increase. While the numbers of both domestic and international passengers have increased, international passenger demand continues to increase at a faster rate than domestic passenger demand. Total international passengers at Logan Airport increased from 5.0 million in 2014 to 5.5 million in 2015, a 10.9-percent increase. International passengers made up approximately 16.1 percent of total Airport passengers in 2015, and this is projected to increase steadily to nearly 20 percent of the total by 2030 or sooner. The 2015 EDR indicates that strong international passenger growth was driven by the economic attractiveness of the metropolitan Boston region and the strength of Boston as an origin and destination market. New international destinations from Logan Airport in 2015 included Mexico City, Hong Kong, Tel Aviv, and Shanghai.

The NPC indicates that passenger activity has continued to grow faster than forecasts provided in the 2015 EDR and that it is outpacing growth in aircraft operations. The 2016 EDR should describe how this trend will support Massport's long-standing goals to reduce overall operating and environmental impacts at the airport. 2016 The EDR should include more discussion of future passenger and activity levels and planning/mitigation to address impacts of growth than that which is typically provided in an EDR.

The 2016 EDR should report on airport activity levels and aircraft operations, including:

- Aircraft operations, including fleet mix and scheduled airline services at Logan Airport;
- Domestic and international passenger activity levels;
- Cargo and mail volumes;

- Compare 2016 aircraft operations, cargo/mail operations, and passenger activity levels to 2015 activity levels; and
- National aviation trends compared to Logan Airport trends.

Sustainability at Logan Airport

The 2015 EDR described Massport's airport wide sustainability goals as identified in its Environmental Management Policy (EMP) and 2015 Sustainability Management Report (SMR). The SMR identifies efforts to promote, coordinate and integrate sustainability Airport-wide. Progress towards achieving these goals was addressed in the 2015 EDR. Massport revised its Sustainable Design Standards and Guidelines (SDSG) in March 2011 which provide a framework for sustainable design and construction for both new construction and rehabilitation projects. Since 2000 Massport has been striving to achieve certification by the U.S. Green Building Council Leadership in Energy and Environmental Design (LEED) for new and substantial rehabilitation of building projects over 20,000 square feet (sf).

The 2016 EDR should report on progress on achieving EMP goals.

Climate Change

Massport assets and Logan Airport, in particular, are critical infrastructure and play an important role in the economy. As recognized in Governor Baker's recent Executive Order 569 "Establishing an Integrated Climate Change Strategy for the Commonwealth" and a suite of other state and municipal initiatives, the impacts of climate change must be an important consideration for development across the state. Climate change presents a serious threat to the environment and the Commonwealth's residents, communities and economy. The EO indicates that extreme weather events associated with climate change present a serious threat to public safety and the lives and property of our residences. The recent flooding and storm damage caused by two storms in early March underscore these risks and the importance of adaptation and resiliency planning.

The EO also identifies the transportation sector as a significant contributor to GHG emissions in the Commonwealth and the only sector in which GHG emissions are increasing. In 2017, EEA and the Massachusetts Department of Transportation (MassDOT) conducted a number of transportation listening sessions throughout the Commonwealth to inform development of strategies and programs to reverse the growth in this sector.

Massport has begun reporting on GHG emissions and, in recognition of the potential effects of climate change on Massport infrastructure and operations, Massport initiated a Disaster and Infrastructure Resiliency Planning (DIRP) Study. A particular concern for Massport is the effect of sea level rise and projected increases in the severity and frequency of storms. The Study includes Logan Airport, the Port of Boston, and Massport's waterfront assets in South and East Boston. The DIRP Study includes a hazard analysis; modeling of projected sea-level rise and storm surge; temperature and precipitation projections; and anticipated increases in extreme weather events.

The 2016 EDR should provide a summary of the DIRP Study and identify which recommendations Massport will implement in the short term to increase the resiliency of its facilities to the potential effects of climate change.

Mitigation

The 2015 EDR identifies the status of mitigation commitments for specific Massport and tenant projects at Logan Airport that have undergone MEPA review. The 2016 EDR will continue to be the forum to address cumulative, Airport-wide impacts. The 2016 EDR should update the status of mitigation commitments for recent projects such as the Terminal E Modernization Project and the Logan Airport Parking Project as well as projects previously included in the 2015 EDR.

Planning

The Airport Planning section of the 2016 EDR should describe the status of projects underway or completed at Logan Airport by the end of 2016 and provide updates for projects in progress. It should address planning, construction, and permitting activities. Specific topics include terminal area projects, service area projects, buffer/open space projects, Airport parking projects, airside area projects, high occupancy vehicle (HOV) improvements, and Airport-wide projects. Project updates include:

- *Terminal E Renovation and Enhancements Project*: This project includes interior and exterior improvements at Terminal E to accommodate regular service by wider and longer Group VI aircraft. The project will reconfigure three gates to accommodate Group VI aircraft (including the Airbus A380 and Boeing 747-8 primarily used by international air carriers) and will reconfigure passenger holdrooms to accommodate larger passenger loads associated with these aircraft. Construction commenced in 2015.

- *Terminal E Modernization Project*: This project will accommodate existing and long range forecasted demand for international service. The expansion will add the three gates approved in 1996 (International Gateway West Concourse project, EEA #9791), which were never constructed, and an additional two to four additional new gates in an extended concourse. A key feature of this project is the first direct pedestrian connection from the MBTA Blue Line Airport Station to the terminal complex at Logan Airport. It will also include improvements to Airport roadways to facilitate access. The project completed MEPA review in 2016. Phase 1 has been permitted and is in the final design stage.

- *Terminal C to E Connector:* This project provides a new post-security connection between Terminals C and E on the Departures Level and provides improved passenger circulation within the post-security concourses, additional holdroom space at Terminal E, reconfigured office space, concessions and concessions support, and a new consolidated location for escalators and stairs. The project was completed in May 2016.

- *Terminal B Airline Optimization Project:* Massport is upgrading its facilities on the Pier B side of Terminal B to meet airlines' needs (primarily reflecting the merger of American Airlines and US Airways) and to provide facilities that improve the passenger traveling

experience. Similar improvements have been implemented with the recent renovations and improvements at Terminal B, Pier A. Planned improvements include an enlarged ticketing hall, improved outbound bag area, expanded bag claim hall, expanded concession areas, and expanded holdroom capacity at the gate.

Logan Airport Parking Project: This project includes the construction of up to 5,000 new commercial parking spaces to reduce trip generation associated with increases in passenger drop-off and pick-up at the airport. The Certificate on the ENF was issued on May 5, 2017 and included a Scope for the Draft Environmental Impact Report (DEIR). This project required an amendment to the Logan Airport Parking Freeze Regulations (310 CMR 7.30). MassDEP proposed amendments to the regulations on March 24, 2017 and amendments were promulgated last year.

In the absence of a 2016 ESPR and the significant public interest in passenger growth, ground access, noise and air quality, the 2016 EDR should provide a broader context for long range planning than would normally be included in an EDR. It should address planning strategies for improving Logan Airport's operations and services in a safe, secure, more efficient, and environmentally sensitive manner. The 2016 EDR should describe the status of planning initiatives for the following areas:

- Roadways and Airport Parking;
- Terminal Area;
- Airside Area;
- Service and Cargo Areas; and
- Airport Buffers and Landscaping.

The 2016 EDR should describe the status and effectiveness of ground access changes, including roadway and parking projects, that consolidate and direct airport-related traffic to centralized locations and minimize airport-related traffic on streets in adjacent neighborhoods.

Regional Transportation

The 2015 EDR describes activity levels at New England's regional airports in 2015 and provides an update on regional planning activities, including long-range transportation efforts. The New England region is anchored by Logan Airport and a system of 10 other commercial service, reliever, and general aviation (GA) airports (regional airports). In 2015, passenger traffic at the New England airports represented the highest passenger traffic level for the region since the economic downturn in 2008 and exceeded the historical peak of 48.0 million in 2005. The increase in the region's passenger traffic was largely driven by continued growth at Logan Airport. In 2015, the total number of air passengers utilizing New England's commercial service airports, including Logan Airport, increased by 4.1 percent from 46.8 million annual air passengers in 2014 to 48.7 million in 2015. Of the 48.7 million passengers, 68.6 percent of passengers (33.4 million) used Logan Airport compared to 67.6 percent (31.6 million) in 2014. Aircraft operations in the region remained flat in 2015, increasing 0.3 percent from 987,652 operations in 2014 to 991,041 operations in 2015.

Regional Airports

- 2016 regional airport operations, passenger activity levels, and schedule data within an historical context;
- Status of plans and new improvements as provided by the regional airport authorities;
- Role of the Worcester Regional Airport and Hanscom Field in the regional aviation system and Massport's efforts to promote these airports; and
- Ground access improvements at Massachusetts Regional Airport.

Regional Transportation System

- Massport's role in managing the regional transportation facilities within MassDOT;
- Massport's cooperation with other transportation agencies to promote efficient regional highway and transit operations; and
- Report on metropolitan and regional rail initiatives and ridership.

<u>Ground Access to and from Logan Airport</u>

The 2015 EDR reports on transit ridership, roadways, traffic volumes, and parking for 2015. Specifically, the EDR states that Massport has continued to invest in and operate Logan Airport with a goal of increasing the number of passengers arriving by transit or other high occupancy vehicle (HOV) modes.

Massport remains in compliance with the Parking Freeze regulations which regulates the number of commercial and employee parking spaces allowed at Logan Airport (total limit of 21,088). Massport submits semi-annual compliance filings to MassDEP; March and September reports are provided in the 2015 EDR. As permitted (and encouraged) by the regulations, Massport has converted employee spaces to commercial spaces, within the overall limits.

The HOV/transit mode share at Logan Airport continues to rank at the top of U.S. airports. At the same time, private passenger vehicle trips continue to increase as air travel grows. Massport has indicated that as passenger levels have increased, the constrained parking supply at Logan Airport has resulted in an increase in pick-up and drop-off vehicle trips. Despite an increase in terminal area parking rates on July 1, 2014, daily parking demand more frequently approached the Parking Freeze cap in 2015. As described previously, Massport is proposing to construct additional parking to reverse this trend.

The Airport's gateway roadways are equipped with permanent traffic count stations, as part of the Airport-wide Automated Traffic Monitoring System (ATMS). These stations provide data on annual average daily traffic (AADT), annual average weekday daily traffic (AWDT), and annual average weekend daily traffic (AWEDT). The AADT (entering and departing Logan Airport via its gateway roadways) increased by 0.1 percent between 2014 and 2015. The change in average daily traffic can be attributed to: a 5.7-percent increase in air passenger activity in 2015; a 3.0-percent increase in taxi dispatches in 2015; and 1.1-percent decrease in parking activity (exits) in 2015. Historically, the highest AADT recorded at Logan Airport was in 2007, when AADT reached 110,690, AWDT was 119,200, and AWEDT was 91,320 that same year. These gateway traffic volumes corresponded to an annual air passenger level of 28,102,455 passengers. Current AADT and AWDT values are 2 and 5 percent (respectively) lower than

current on-Airport traffic volumes despite a 19.0-percent increase in air passenger levels from 2007 to 2015.

On-Airport VMT is calculated based on the total number of miles traveled by all vehicles within the Logan Airport roadway system. In 2011 as detailed in the 2011 ESPR, Massport upgraded its modeling capabilities and began using an on-Airport VISSIM-10 model to estimate VMT. Based on the ATMS data, the change in on-Airport daily traffic volumes between 2014 and 2015 was negligible. However, 2015 evening peak hour gateway volumes grew by roughly 5 percent when compared to 2014. Additionally, a shift in gateway traffic entering/exiting the Airport from the Ted Williams Tunnel to the Sumner/Callahan Tunnels was noted. Daily traffic volumes in the Ted Williams Tunnel decreased by 8.4 percent (from 49,600 to 45,400 vehicles) while volumes in the Sumner/Callahan Tunnels increased by 19.5 percent (from 29,800 to 35,600 vehicles). Since 2000, the highest average weekday VMT estimated at Logan Airport was in 2007, when weekday VMT was modeled at 184,613.

The 2015 EDR describes improvements to support HOV access which include: Back Bay Logan Express pilot service (since May 2014); free MBTA Silver Line outbound (from Logan Airport) boardings; a 1,100-car parking garage at the Framingham Logan Express; reduced holiday travel parking rates at Logan Express facilities; increased parking rates on the Airport; and support for private coach bus and van operators.

As noted previously, TNCs such as Lyft and Uber that did not exist just a few years ago are becoming prominent providers of Logan Airport passenger ground access/egress. According to the NPC, this new mode is already beginning to have a dramatic impact on how passengers arrive and depart Logan Airport. Using TNC data collected since February 2017 when TNCs began picking up at Logan will provide a better indication of future ground access mode share than using limited 2016 information. The 2016 EDR should describe how this TNC data collection and analysis will be incorporated into the 2017 ESPR.

The 2016 EDR should report on 2016 ground access conditions at the airport and provide a comparison of 2016 findings to those of 2015 for the following:

- Detailed description of compliance with Logan Airport Parking Freeze;
- High-occupancy vehicle (HOV) ridership (including Blue Line, Silver Line, Water Transportation, and Logan Express);
- Logan Airport Employee Transportation Management Association (Logan TMA) services;
- Logan Airport gateway volumes;
- On-airport traffic volumes;
- On-airport vehicle miles traveled (VMT);
- Parking demand and management (including rates and duration statistics);
- Status of long-range ground access management strategy planning;
- Results of the 2016 Logan Airport Air Passenger Survey; and,
- Status of proposed connector to the Airport Station associated with the planned Terminal E Modernization Project.

The 2016 ESPR should address the following topics:

- Massport's target HOV mode share along with incentives;
- Non-Airport through-traffic;
- Massport's cooperation with other transportation agencies to increase transit ridership to and from Logan Airport via the Blue Line, Silver Line, Water Transportation, and Logan Express;
- Report on Logan Express usage and efforts to increase capacity and usage;
- Progress on enhancing water transportation to and from Logan Airport;
- Report on results of ground access study; and
- Strategies for enhancing services and increasing employee membership in the Logan Airport TMA.

<u>Noise</u>

The 2015 EDR updated the status of the noise environment at Logan Airport in 2015, and described Massport's efforts to mitigate noise exposure and impacts. As noted previously, the implementation of RNAV has resulted in concentration of flight patterns over certain communities and significant increases in noise exposure. At the same time, the FAA introduced the AEDT for modeling noise and air quality. Massport did not submit AEDT modeling results for 2015. Noise was modeled using the FAA INM. Massport will use the AEDT for noise modeling for the 2016 EDR.

Compared to 2000, overall operations were down by 23.6 percent while overall passengers were up by 20.6 percent; jet operations made up 86 percent of operations compared to 66 percent; and the number of people exposed to Day-Night Average Sound Level (DNL) 65 decibels (dB) has declined by 20.6 percent.

Compared to 2014, the 2015 DNL 65 dB noise contours were larger in most areas around the Airport due to changes in: (1) runway usage, primarily as a result of wind and weather conditions, (2) an increase in the number of nighttime operations, and (3) an increase in the number of overall operations. The overall number of people exposed to DNL values greater than or equal to 65 dB increased by 58.0 percent, from 8,922 people in 2014 to 14,097 people in 2015.

Runway use changes from 2014 to 2015 were the largest factor in the increase in the number of people exposed to DNL values greater than or equal to 65 dB. The DNL contour increased in East Boston and slightly in South Boston due to an increase in Runway 22R departures. Increased departures from Runway 22L also resulted in increases in Winthrop. Increased arrivals to Runways 22L and 27 at night contributed to increases in Revere and Winthrop. Unlike 2014, 2015 reflects almost a full year of the head-to-head night noise abatement procedures on Runway 15R-33L. While this reduces overall noise exposure by concentrating operations over water rather than over populated areas, it increases start-of-takeoff-roll noise in East Boston, north and west of the Runway 15R end. Lower use of Runway 4R for arrivals in 2015 resulted in a reduction in the contour south of the Airport.

An additional factor influencing noise contour changes in 2015 was a 5.7-percent increase in nighttime operations (from 48,056 nighttime operations in 2014 to 50,786 nighttime operations in 2015). This increase in overall operations and nighttime operations is still well below the peak of 54,038 annual operations at night reached in 1999. As airlines have expanded to new destinations, the number of commercial operations, and in turn the number of nighttime operations, has increased. In 2015, there was an increase of 7.5 nighttime operations per day compared to 2014.

The overall increase in operations was smaller than the increase in nighttime operations (2.5 percent overall versus 5.7 percent nighttime), but contributed to the expansion of the noise contours. The DNL and population levels in 2015 remain well below the peak levels reached in 1990 and are less than in the year 2000 when 17,745 people were exposed to DNL levels greater than or equal to DNL 65 dB. The 2015 DNL 65 dB contour is somewhat larger than the 2014 DNL 65 dB contour. Almost all of the residences exposed to levels greater than or equal to DNL 65 dB in 2015 have been eligible to participate in Massport's residential sound insulation program (RSIP).

To date, Massport has provided sound insulation for a total of 11,515 residential units, and will continue to seek funding for sound insulation for properties that are eligible and whose owners have chosen to participate. The 2016 EDR should provide an overview of the environmental regulatory framework affecting aircraft noise, the changes in aircraft noise, and the updates in noise modeling. The chapter should report on 2016 conditions and provide a comparison to 2015 for the following:

- Fleet Mix, including Stage II, Recertified Stage III, newly manufactured Stage III, and qualifying Stage IV aircraft;
- Nighttime operations;
- Runway utilization (report on aircraft and airline adherence with runway utilization goals);
- Preferential runway advisory system (PRAS) tracking; and
- Flight tracks.

The 2016 EDR will be based on AEDT for the first time. The initial analysis will provide a baseline from which to project noise conditions in the future.

Noise contours for 2016 should be developed using AEDT and compared to the most recent version of the INM which has been in place for all previous EDRs and ESPRs. The 2016 EDR should report on the following:

- Changes in annual noise contours and noise-impacted population;
- Measured versus modeled noise values, including reasons for differences and any improvements attributable to the models deployed;
- Cumulative Noise Index (CNI);
- Times-Above for 65, 75, and 85 dBA threshold values/Dwell and Persistence of noise levels; and
- Flight track monitoring noise reports.

The 2016 EDR should also report on noise abatement efforts, results from Boston Logan Airport Noise Study (BLANS) study, and provide an update on the noise and operations monitoring system.

Air Quality/Emissions Reduction

The 2015 EDR provided an overview of airport-related air quality issues in 2015 and efforts to reduce emissions. The air quality modeling is based on aircraft operations, fleet mix characteristics, and airfield taxiing times combined with ground support equipment (GSE) usage, motor vehicle traffic volumes, and stationary source utilization rates. Total air quality emissions from all sources associated with Logan Airport are significantly lower than a decade ago.

In 2015, calculated emissions of volatile organic compounds (VOCs), oxides of nitrogen (NOx), carbon monoxide (CO), and particulate matter (PM) went up slightly compared to 2014. The increase is primarily due to the corresponding increase in aircraft landing and take offs (LTOs) and airfield taxi times. Total emissions of VOCs increased by 1 percent in 2015 to 1,188 kilograms (kg)/day compared to1,177 kg/day in 2014, which is still well below 1990 and 2000 levels. Total NOx emissions increased by approximately 5 percent in 2015, to 4,262 kg/day compared to 2014 levels of 4,040 kg/day. Massport's voluntary Air Quality Initiative (AQI) has tracked NOx emissions since the benchmark year of 1999. In the final year of this program (2015), total NOx emissions were 632 tons per year (tpy) lower than the 1999 benchmark. This represents a decrease of 27 percent in NOx emissions over the past 15 years. Between 1999 and 2015, the greatest reductions of NOx emissions were associated with aircraft, ground service equipment (GSE), and on-Airport motor vehicles at 17 percent, 71 percent, and 87 percent reductions, respectively. Massport has committed to continue to report on NOx emissions as part of the Logan Airport emissions inventory in future EDRs/ESPRs. Total CO emissions increased by about 3.5 percent in 2015 to 7,243 kg/day, from 6,987 kg/day in 2014; emissions in 2015 were still well below 1990 and 2000 levels. Total PM10/PM2.5 emissions also increased by about 3 percent in 2015 to 98 kg/day, from 95 kg/day in 2014.

The increases are associated with transportation and a significant portion is due to changes in modeling from MOBILE 6.2.03 to MOVES 2014a. Use of this program provides consistency with the State Implementation Plan (SIP) and MassDEP's methodologies.

The 2015 EDR contains a greenhouse gas (GHG) emissions inventory for the Logan Airport EDR. In 2015, total GHG emissions grew by 6 percent. As reported in past year EDRs, Logan Airport-related GHG emissions in 2015 comprised less than 1 percent of statewide totals.

The 2016 EDR should contain an overview of the environmental regulatory framework affecting aircraft emissions, changes in aircraft emissions, and the changes in air quality modeling. The 2016 EDR should also provide discussion on progress on the national and international levels to decrease air emissions. Massport has committed to use the FAA's AEDT model for air emissions modeling. The 2016 EDR should compare results to the most recent version of the Emissions Dispersion Modeling System (EDMS) that has been used in recent EDR filings.

The EPA Motor Vehicle Emission Simulator (MOVES) tool will continue to be used to assess vehicular emissions on airport roadways. The 2016 EDR should include an emissions inventory for CO, NOx, VOCs, and PMs. It should also report on Massport and tenant alternative fuel vehicle programs and the status of Logan Airport air quality studies undertaken by Massport or others, as available.

The 2016 EDR should incorporate GHG emissions reporting. The 2015 EDR provided extensive data on GHG emissions. As required in the Certificate on the 2015 EDR, Massport should consider changes to the presentation of this data and normalizing it to support effective review and analysis. Massport should consult with the MEPA Office and DOER regarding presentation of GHG data in the 2016 EDR and subsequent ESPR.

The 2016 EDR GHG emissions should continue to be quantified for aircraft, GSE, motor vehicles and stationary sources using emission factors and methodologies outlined in the *Greenhouse Gas Emissions Policy and Protocol* issued by EEA and the Transportation Research Board's *Guidebook on Preparing Airport Greenhouse Gas Emissions Inventories* (Airport Cooperative Research Program (ACRP) Report 11, Project 02-06). The results of the 2016 GHG emissions inventory should be compared to the 2015 results.

Massport should also provide an update on its efforts to encourage the use of single engine taxiing under safe conditions. In addition, the 2016 EDR should provide an update on the feasibility of combined heat and power (CHP) use for Terminal E and updates to progress made in designing the energy systems for the facility.

<u>Water Quality/Environmental Compliance</u>

The 2015 EDR describes Massport's ongoing environmental management activities including National Pollutant Discharge Elimination System (NPDES) compliance, stormwater, fuel spills, activities under the Massachusetts Contingency Plan (MCP), and tank management. Massport's primary water quality goal is to prevent or minimize pollutant discharges, thus limiting adverse water quality impacts of airport activities. Massport employs several programs to promote awareness of activities that may impact surface and groundwater quality. Programs include implementing best management practices (BMPs) for pollution prevention by Massport, its tenants, and its construction contractors; training of staff and tenants; and a comprehensive stormwater pollution prevention plan.

The 2016 EDR should identify any planned stormwater management improvements and report on the status of:

- NPDES Permit and monitoring results for Logan outfalls and the Fire Training Facility;
- Jet fuel usage and spills;
- MCP activities;
- Tank management;
- Update on the environmental management plan; and
- Fuel spill prevention.

Conclusion

Massport may prepare a 2016 EDR for submission in 2018 consistent with the Scope included in this Certificate. Massport has indicated that the 2016 EDR will be filed within the next few months. The 2016 EDR should include a draft Scope for the 2017 ESPR and identify a date by which the 2017 ESPR will be filed. I encourage Massport to target early 2019 for filing of the 2017 ESPR.

March 9, 2018
Date

Matthew A. Beaton

No comments received.

MAB/ACC/acc

Comment #	Author	Topic	Comment	Responses Updated for 2017 ESPR
NPC-1	Matthew Beaton, Secretary	2016 EDR Scope	• Massport will submit a 2016 EDR in lieu of the ESPR. • The 2016 EDR will supplement typical EDR data reporting with discussion of future passenger and activity levels, planning to address growth and strategies to minimize environmental impacts. • The 2016 EDR will include a draft Scope for the 2017 ESPR and identify when the ESPR will be filed.	Massport prepared the *2016 Logan Airport Environmental Data Report (EDR)* in lieu of a 2016 Environmental Status and Planning Report (ESPR) which was published in May 2018. The *2016 EDR* continued to provide documentation on environmental conditions for the reporting year compared to the previous year. This *2017 ESPR* includes updated long-range forecasts and assesses future impacts for noise, air quality, and ground access and follows the scope that was outlined in the Notice of Project Change (NPC) Certificate as well as the Certificate on the *2016 EDR.* This *2017 ESPR* is published on July 30, 2019.
NPC-2	Matthew Beaton, Secretary	Ground Access	Massport has been collecting TNC data since February 2017 when TNCs began picking up, in addition to dropping off, at Logan. The 2017 ESPR will include limited data from 2016 and a year of data for 2017.	The *2017 ESPR* reports on transportation network company (TNC) data collected at Logan Airport for 2017 in Chapter 5, *Ground Access to and from Logan Airport.* TNCs, such as Uber and Lyft, are increasingly becoming a mode of choice for ground-access at airports throughout the country. Beginning in February 2017, Massport began allowing TNCs to pick-up arriving air passengers via a TNC pool lot and collecting that activity data. This is a service that is being tracked for future reporting. In this *2017 ESPR* , Massport has introduced a new definition of high-occupancy vehicle (HOV) modes, updating the definition to include the increased knowledge and data from the rapidly changing transportation landscape with the emergence of TNCs and the impacts on the ground access network. Beginning with the next air passenger ground access survey, Massport will define HOV based on vehicle occupancy; taxis, black car limousines, and TNCs that carry two or more air passenger per vehicle will be counted as HOV while the same modes with one air passenger will count as non-HOV. With this updated definition, Massport has committed to a goal of 35.5 percent HOV by 2022 and 40 percent by 2027.
NPC-3	Matthew Beaton, Secretary	Responses to Comments	The 2016 EDR must also respond to those issues explicitly noted in this Certificate and the comments received on the 2015 EDR and noted in the February 17, 2017 Certificate.	The *2016 EDR* responded to all issues raised in the Certificate on the *2015 EDR* and the 2016 EDR Notice of Project Change in Appendix A, *MEPA Certificates and Responses to Comments.* The *2016 EDR* also responded to all comments received on the *2015 EDR* in Appendix B, *Comment Letters and Responses.* No comments were received on the 2016 Notice of Project Change. The *2017 ESPR* includes updated responses to the Certificate on the NPC, herein.
NPC-4	Matthew Beaton, Secretary	Responses to Comments	The Response to Comments section should address all of the substantive comments on the 2015 EDR, and other Certificates for Logan Airport that reference EDR/ESPR documentation (e.g. Logan Airport Parking Project, Terminal E).	The *2016 EDR* responded to all issues raised in the Certificate on the *2015 EDR,* and in the 2016 EDR Notice of Project Change Certificate, the Terminal E Modernization Environmental Notification Form (ENF) and Draft Environmental Assessment (EA)/Environmental Impact Report (EIR), and the Certificate on the Logan Airport Parking Project ENF in Appendix A, *MEPA Certificates and Responses to Comments.* The *2016 EDR* also responded to all comments received in Appendix B, *Comment Letters and Responses.* This *2017 ESPR* addresses the ESPR/EDR-related items raised in the certificates on the Terminal E Modernization Draft EA/EIR and the Parking Garages ENF. The Parking Garages Draft EA/EIR was published on May 31, 2019 and is undergoing agency and public review. Additional updates are provided in this *2017 ESPR.*
NPC-5	Matthew Beaton, Secretary	Ground Access, Air Quality, Public Health	The 2016 EDR should include sufficient information to address comments on traffic, air quality and public health which are common concerns of commenters.	The *2016 EDR* included information pertaining to traffic in Chapter 5, *Ground Access to and from Logan Airport* and information pertaining to air quality and public health in Chapter 7, *Air Quality/Emissions Reduction.* Additional updates are provided in this *2017 ESPR.*

Comment #	Author	Topic	Comment	Responses Updated for 2017 ESPR
NPC-6	Matthew Beaton, Secretary	Activity Levels , Planning	The NPC indicates that passenger activity has continued to grow faster than forecasts provided in the 2015 EDR and that it is outpacing growth in aircraft operations. The 2016 EDR should describe how this trend will support Massport's long-standing goals to reduce overall operating and environmental impacts at the airport. The 2016 EDR should include more discussion of future passenger and activity levels and planning/mitigation to address impacts of growth than that which is typically provided in an EDR.	The *2016 EDR* reported on current and historical passenger activity levels and aircraft operations in Chapter 2, *Activity Levels.* The *2017 ESPR* reports trends in annual passenger and operations activity levels from 1990 through 2017 and includes updated long-range forecasts for passenger activity levels and aircraft operations. Boston's prominence in technical and higher education industries coupled with substantial local and regional economic growth, have been key drivers in the passenger and operational growth. This *2017 ESPR* presents the forecasts for passenger and operations through the Future Planning Horizon, and assesses the potential environmental impacts associated with a 50 million annual air passenger forecast. The effect of anticipated future aircraft operations and passenger activity levels are discussed in the applicable technical chapter, Chapter 2, *Activity Levels,* Chapter 5, *Ground Access to and From Logan Airport,* Chapter 6, *Noise Abatement,* and Chapter 7, *Air Quality/Emissions Reduction.*
NPC-7	Matthew Beaton, Secretary	Planning	In the absence of a 2016 ESPR and the significant public interest in passenger growth, ground access, noise and air quality, the 2016 EDR should provide a broader context for long range planning than would normally be included in an EDR. It should address planning strategies for improving Logan Airport's operations and services in a safe, secure, more efficient, and environmentally sensitive manner.	Chapter 2, *Activity Levels* and Chapter 3, *Airport Planning* of this *2017 ESPR* provide updates on current and future activity levels, and updates on planning efforts through the date of filing.
NPC-8	Matthew Beaton, Secretary	Ground Access	Using TNC data collected since February 2017 when TNCs began picking up at Logan will provide a better indication of future ground access mode share than using limited 2016 information. The 2016 EDR should describe how this TNC data collection and analysis will be incorporated into the 2017 ESPR.	TNCs, such as Uber and Lyft, are increasingly becoming a mode of choice for ground-access at airports throughout the country. Data from the 2016 Logan Airport Air Passenger Ground Access Survey show a number of departing air passengers choosing TNCs. Beginning in February 2017, Massport began allowing TNCs to pick-up arriving air passengers via a TNC pool lot and collecting that activity data. This is a service that is being tracked for future reporting. TNC information for 2017 is included in this *2017 ESPR.* In this *2017 ESPR,* Massport has introduced a new definition of HOV modes, updating the definition to include the increased knowledge and data from the rapidly changing transportation landscape with the emergence of TNCs and the impacts on the ground access network. Beginning with the next air passenger ground access survey, Massport will define HOV based on vehicle occupancy; taxis, black car limousines, and TNCs that carry two or more air passenger per vehicle will be counted as HOV while the same modes with one air passenger will count as non-HOV. With this updated definition, Massport has committed to a goal of 35.5 percent HOV by 2022 and 40 percent by 2027.
NPC-9	Matthew Beaton, Secretary	Noise Abatement	Massport will use the AEDT for noise modeling for the 2016 EDR.	For this *2017 EDR,* Massport used the Federal Aviation Administration (FAA)-required Airport Environmental Design Tool (AEDT) model. To assist the reviewer, Massport provided the 2016 INM noise contours for comparison with the 2016 AEDT noise contours in the *2016 EDR.* In this ESPR and in future EDRs and ESPRs, Massport will only use AEDT for modeling noise.
NPC-10	Matthew Beaton, Secretary	Air Quality	Massport has committed to use the FAA's AEDT model for air emissions modeling. The 2016 EDR should compare results to the most recent version of the Emissions Dispersion Modeling System (EDMS) that has been used in recent EDR filings.	For this *2017 ESPR,* Massport used the FAA-required AEDT model. To assist the reviewer, the *2016 EDR* provided 2016 results using both the legacy EDMS model and new AEDT model. In this ESPR and in future EDRs and ESPRs, Massport will only use AEDT for modeling emissions.

Comment #	Author	Topic	Comment	Responses Updated for 2017 ESPR
NPC-11	Matthew Beaton, Secretary	Air Quality	As required in the Certificate on the 2015 EDR, Massport should consider changes to the presentation of this data and normalizing it to support effective review and analysis. Massport should consult with the MEPA Office and DOER regarding presentation of GHG data in the 2016 EDR and subsequent ESPR.	In response to the March 9, 2018 Secretary's Certificate on the 2016 EDR Notice of Project Change, Massport has augmented its GHG reporting to show normalized GHG emissions and building energy use data (see Chapter 7, *Air Quality/Emissions Reduction* of this *2017 ESPR).* Normalizing the data shows that Logan Airport is operating more efficiently over time, serving more passengers in larger building footprints with less energy.
NPC-12	Matthew Beaton, Secretary	2017 ESPR Scope	The 2016 EDR should include a draft Scope for the 2017 ESPR and identify a date by which the 2017 ESPR will be filed. I encourage Massport to target early 2019 for filing of the 2017 ESPR.	The *2017 ESPR* follows the scope outlined in the Certificate on the NPC for the *2016 EDR/ESPR.*

Copies of the Secretary of the Executive Office of Energy and Environmental Affairs Certificates issued for the Reporting Years 2015, 2014, 2012/2013, and 2011

This Page Intentionally Left Blank.

The Commonwealth of Massachusetts
Executive Office of Energy and Environmental Affairs
100 Cambridge Street, Suite 900
Boston, MA 02114

Charles D. Baker
GOVERNOR

Karyn E. Polito
LIEUTENANT GOVERNOR

Matthew A. Beaton
SECRETARY

Tel: (617) 626-1000
Fax: (617) 626-1181
http://www.mass.gov/envir

February 17, 2017

CERTIFICATE OF THE SECRETARY OF ENERGY AND ENVIRONMENTAL AFFAIRS
ON THE
2015 LOGAN AIRPORT ENVIRONMENTAL DATA REPORT

PROJECT NAME	: 2015 Environmental Data Report
PROJECT MUNICIPALITY	: Boston/Winthrop
PROJECT WATERSHED	: Boston Harbor
EOEA NUMBER	: 3247
PROJECT PROPONENT	: Massachusetts Port Authority
DATE NOTICED IN MONITOR	: December 21, 2016

As Secretary of Executive Office of Energy and Environmental Affairs (EEA), I hereby determine that the Environmental Data Report submitted on this project **adequately and properly complies** with the Massachusetts Environmental Policy Act (MEPA) (M.G.L. c. 30, ss. 61-62I) and with its implementing regulations (301 CMR 11.00).

The environmental review process for Logan Airport has been structured to occur on two levels: airport-wide and project-specific. The Environmental Status and Planning Report (ESPR) has evolved from a largely retrospective status report on airport operations to a broader analysis that also provides a prospective assessment of long-range plans. It has thus become, consistent with the objectives of the MEPA regulations, part of the Massachusetts Port Authority's (Massport) long-range planning process. The ESPR provides a "big picture" analysis of the environmental impacts of current and anticipated levels of activities, and presents an overall strategy to minimize impacts. The ESPR is supplemented by (and ultimately incorporates) the detailed analyses and mitigation commitments for project-specific Environmental Impact Reports (EIR). The ESPR is generally updated on a five-year basis; the most recent ESPR for the year 2011 was filed in April of 2013. Environmental Data Reports (EDRs) (formerly referred to as Annual Updates) are filed in the years between ESPRs.

Through these reports, Logan Airport is subject to comprehensive and regular MEPA review, including opportunities for public comment on cumulative impacts. This regular updating and reporting on planning and cumulative impacts is unique among State Agencies. It reflects the challenge and complexity of managing and modernizing Logan Airport within a dense, urban area. It recognizes that the proximity of communities to the Airport warrants an enhanced level of public engagement and a concerted, long-term effort to minimize and mitigate impacts.

The 2015 EDR is the subject of this review and includes the Scope for the 2016 ESPR. The 2016 ESPR is an opportunity to update the cumulative impacts of passenger growth and associated ground and aircraft operations based on revised forecasts. The 2016 ESPR will document trends and environmental impacts and will update and revise environmental management plans to address impacts. A-1
The next ESPR will analyze calendar year 2016 and provide projections through 2035. A-2

Subsequent ESPRs and EDRs will also update the cumulative impacts of passenger growth and associated ground and aircraft operations based on revised forecasts and will update and revise environmental management plans to address impacts. Future submittals will continue to document potential impacts and trends and propose measures to implement the broad goal of maintaining or reducing Logan's overall environmental impacts, even as annual passenger volumes rise. I would like to acknowledge Massport's concerted outreach effort over the last year, including the creation of the Logan Airport Impact Advisory Group (IAG) to solicit comment and to identify and prioritize projects and programs of significance to the IAG.

The 2015 EDR provides a comprehensive, cumulative analysis of the effects of all Logan Airport activities based on actual passenger activity and aircraft operational levels, provides updates on projects, environmental management plans and the status of project mitigation. The 2016 ESPR will report on updated passenger activity levels, aircraft operations forecasts, and environmental conditions forecasts. A-3

Review of the 2015 EDR and
Scope for the 2016 ESPR

In 2015, Logan Airport served an all-time high of 33.4 million passengers, exceeding the 2014 historic peak. A significant portion of growth in passengers is driven by an increase in demand for international air service. Massport has provided new service to international destinations and expandined service to existing destinations. As passenger levels have increased, aircraft operations remain significantly below the peak of 507,449 operations experienced in 1998 when Logan Airport served 26.5 million passengers.

The long-term trend is towards more efficient operations and reductions or limited increases in overall environmental impacts. Although environmental impacts are significantly lower compared to 1998 when operations were highest, comparison of activity level and environmental impact data to 2014 and more recent EDRs identifies increases in noise exposure and air emissions. These increases were not forecast in the 2011 ESPR. The increases are associated with passenger growth, changes in flight patterns and changes in modeling of noise and air quality. A significant impact since 2011 is the introduction by the Federal Aviation Administration (FAA) of changes to area navigation (RNAV) procedures. The RNAV program has been implemented throughout the country and its primary purpose

is to increase safety and operational efficiency. The implementation of several of these procedures have resulted in concentration of flight patterns over certain communities and significant increases in noise exposure.

The impact of the RNAV program on communities and individuals is clearly reflected in the many comment letters received on the EDR and received during review of specific projects, including the Terminal E Modernization Project (EEA# 15434). In addition, the 2015 EDR indicates that noise complaints have grown significantly. I have received comment letters from elected officials including U.S. Senator Elizabeth Warren, the City of Quincy's Office of Council, and the Milton Office of Selectmen); the Logan Airport Community Advisory Committee; environmental advocacy groups; businesses; and residents. Massport and the FAA recently signed a Memorandum of Understanding (MOU) to frame a process for analyzing opportunities to incrementally reduce noise through changes or amendments to Performance Based Navigation (PBN), including RNAV procedures. I commend Massport and the FAA for establishing this agreement and committing to coordinate to address the impact of the RNAV program on citizens and communities. A-4 Massport has indicated that this process will incorporate community outreach and public input. This effort should be a significant focus of the 2016 ESPR.

In addition to noise impacts and abatement, traffic and air quality are common concerns of commenters. Several commenters express continued concern with the effects of ultrafine particulates (less than 100 nanometers in diameter) which are associated with transportation sources, including aviation. Massport has proposed that the Massachusetts Department of Environmental Protection (MassDEP) amend the Logan Airport Parking Freeze Regulation (310 CMR 7.30) so that Massport may increase on-airport parking. Massport has proposed increasing its parking supply, if the regulations are amended, to reduce trip generation associated with increases in passenger drop-off and pick-up at the airport. Commenters are concerned that the lifting of the Parking Freeze will lead to increases in long-term growth in traffic and congestion. A-5 I expect the data provided in the 2015 EDR will inform any project-specific review which would include review of potential environmental impacts and of project-specific impact avoidance, minimization, and mitigation measures. I note that commenters have requested to review data that supports Massport's assertion including data from its parking survey. A-6

The EDR includes a significant amount of information and data which can be analyzed to understand historical conditions and trends as well as compare data on an annual basis or to significant milestones or benchmarks. For instance, the EDR identifies and refers to 1998 because it represents the maximum number of operations, references 2000 because that marks the beginning of a concerted effort to identify and track sustainability indicators to guide programs and mitigation, and references 2008-9 because of the economic recession and its associated effect on activity levels. Equally important to monitoring and historical data, are projections to understand how past or existing trends may affect future conditions. The 2011 ESPR projected year was 2030 and the 2016 ESPR projected year will be 2035. Many of the comments received question the relevance of comparison to certain years, assert that too much emphasis has been placed on historical trends rather than recent increases in certain indicators, and/or question the accuracy of data analysis. Massport has responded to comments regarding data in the past by improving the organization, content and presentation of data and analysis of the ESPR and EDR. The 2014 EDR in particular was a significant improvement and the 2015 EDR continues this trend.

The 2015 EDR identifies additional data collection and identifies changes in modeling programs that are designed to more accurately estimate impacts but may produce different results based on same inputs (i.e. a decrease in emissions could result from a change in modeling rather than an actual reduction in emissions). Also Massport has expanded its reporting on greenhouse gas (GHG) emissions to include tenants and ground access passenger vehicles as well as indirect sources.

The FAA Aviation Environmental Design Tool (AEDT) which was introduced in 2015 is a significant change in modeling of noise and air quality. FAA is requiring airports to use AEDT for National Environmental Policy Act (NEPA) review projects and soundproofing eligibility. The tool models aircraft performance in space and time to produce fuel burn, emissions, and noise information. The EDR indicates that Massport initiated modeling with AEDT but had concerns that it did not accurately reflect the noise environment at Logan Airport. A-7 Massport consulted with FAA and determined that the AEDT results would not be published in the 2015 EDR. Massport is evaluating the new model and working with the FAA to develop the types of Logan Airport specific adjustments for the AEDT model that have been used for many years in the Integrated Noise Model (INM). Massport has requested that the FAA consider and approve these adjustments and indicates that, if completed in a timely fashion, AEDT modeling results would be presented in the 2016 ESPR.

Based on significant changes in operations, modeling and data collection, the 2016 EDR provides an opportunity to reconsider data collection, presentation and analysis. I expect Massport will consider the many thoughtful comments provided on these issues and will provide a comprehensive A-8 analysis of these significant changes (e.g. RNAV, AEDT) and results and projections may be influenced by them.

<u>General</u>

The 2016 ESPR should follow the general format of the 2011 ESPR, presenting major policy discussions and an overview of the role of Logan Airport in the regional planning context. A-9 This should be followed by a status report on Massport's planning initiatives, projects, and mitigation measures. The ESPR should include an Executive Summary and Introduction, similar to previous ESPRs and EDRs. Massport must provide necessary background information to allow reviewing agencies and the public to understand the environmental policies and planning which form the context of the environmental A-10 reporting, technical studies, and environmental mitigation initiatives at Logan Airport. Some commenters acknowledged Massport's efforts to increase outreach and resources, including providing A-11 translation at meetings and translation of the EDR Executive Summary into Spanish.

The 2016 ESPR should report on updated passenger and operations activity forecasts for Logan Airport, Hanscom Field and Worcester Regional Airport. A-12 The new forecast used should begin with 2016 as the base year and project activity forecasts forward to calendar year 2035. In addition, the 2016 ESPR will use the results of the 2016 Logan Airport Air Passenger Ground Access Survey and the Long-term A-13 Parking Management Plan to inform transportation planning.

The technical studies in the 2016 ESPR should include reporting on and analysis of key A-14 indicators of airport activity levels, the regional transportation system, ground access, noise, air quality, environmental management, and project mitigation tracking. The 2016 ESPR must also respond to issues explicitly noted in this Certificate and the comments received on the 2015 EDR. A-15

A distribution list for the 2016 ESPR (indicating those receiving documents, CDs, or Notices of Availability) should be provided in the document. This section must also include copies of all ESPR and EDR Certificates issued since the 2011 Logan ESPR to provide context for reviewers. Supporting technical appendices should be provided as necessary. A-16 A-17 A-18

Responses to Comments

To ensure that the issues raised by commenters are addressed, the 2016 ESPR should include direct responses to comments to the extent that they are within MEPA jurisdiction. This directive is not intended to, and shall not be construed to, enlarge the scope of the 2016 ESPR beyond what has been expressly identified in this Certificate. I recommend that Massport continue to use the format from the EDR; however, it should limit references to a section of the 2016 ESPR unless they are directly responsive to the comment. Common themes that should be addressed throughout the ESPR and in the Responses to Comments include noise modeling, contours and abatement. The 2016 ESPR should include sufficient information to address comments on traffic and air quality. Massport should consult directly with individual commenters as appropriate. A-19 A-20 A-21 A-22

Activity Levels

This section reports on annual air traffic activity at Logan Airport in 2015, including air passengers, aircraft operations, aircraft fleet mix, and cargo volumes. Air traffic activity levels at Logan Airport are the basis for the evaluation of noise, air quality effects, and ground access conditions. In this section, current activity levels at the Airport are compared to prior-year levels, and historical passenger and operations trends at Logan Airport dating back to 2000 which is the year Massport approved an Environmental Management Policy. The total number of air passengers increased by 5.7 percent to 33.4 million in 2015, compared to 31.6 million in 2014. As noted previously, the 2015 passenger level represents a record high for Logan Airport.

Passenger aircraft operations accounted for 91 percent of total aircraft operations in 2015. The total number of aircraft operations increased from 363,797 in 2014 to 372,930 in 2015, a 2.5-percent increase. This was preceded by a 0.7 percent increase from 2013 to 2014. Operations are increasing compared to previous years; however, aircraft operations at remained below the 487,996 operations in 2000 and the historical peak of 507,449 achieved in 1998. In 1998, Logan Airport served 26.5 million air passengers, compared to 33.4 million in 2015, which saw 134,519 fewer operations.

Air carrier efficiency continued to improve in 2015 as the average number of passengers per aircraft operation at Logan Airport grew from 87.0 in 2014 to 89.7 in 2015. While the number of domestic and international passengers is increasing, international passenger demand is projected to increase at a faster rate than domestic passenger demand. Annual domestic passengers' activity levels increased from 26.5 million in 2014 to 27.8 million in 2015, a 4.8-percent increase. Total international passengers at Logan Airport increased from 5.0 million in 2014 to 5.5 million in 2015, a 10.9-percent increase. International passengers made up approximately 16.1 percent of total Airport passengers in 2015, and this is projected to increase steadily to nearly 20 percent of the total by 2030 or sooner. The strong international passenger growth was driven by the economic attractiveness of the metropolitan

Boston region and the strength of Boston as an O&D market. New international destinations from Logan Airport in 2015 included Mexico City, Hong Kong, Tel Aviv, and Shanghai.

The 2016 ESPR should report on airport activity levels and aircraft operations, including: A-23

- Aircraft operations, including fleet mix and scheduled airline services at Logan Airport;
- Domestic and international passenger activity levels;
- Cargo and mail volumes;
- Compare 2016 aircraft operations, cargo/mail operations, and passenger activity levels to 2015 activity levels; and
- Report on national aviation trends in 2016 and compare to trends at Logan Airport.

It should report on forecasting upon which planning and impact sections will be based for the next five years. Future year analyses should be based on the 2035 forecast. It should update the aircraft operations and passenger activity forecasts, and provide a discussion of analysis methodologies and assumptions, including anticipated fleet mix changes and other trends in the aviation industry. It should also provide: A-24

- A comparison of 2016 operations to historic trends and 2035 forecasts;
- Updated forecasts of Logan Airport's passenger volume, aircraft operations, and fleet mix; and
- A comparison of forecast activity levels to Massport forecasts, FAA forecasts and the U.S. aviation industry.

Sustainability at Logan Airport

The 2015 EDR describes Massport's airport wide sustainability goals as identified in its Environmental Management Policy (EMP) and 2015 Sustainability Management Report (SMR). The SMR identifies efforts to promote, coordinate and integrate sustainability Airport-wide. A baseline data assessment was completed in winter 2014 to assess current sustainability performance at the Airport.

The 2015 EDR reports its progress towards achieving each goal. Massport revised its Sustainable Design Standards and Guidelines (SDSG) in March 2011 which provide a framework for sustainable design and construction for both new construction and rehabilitation projects. Since 2000 Massport has been striving to achieve certification by the U.S. Green Building Council Leadership in Energy and Environmental Design (LEED) for new and substantial rehabilitation of building projects over 20,000 square feet (sf). The Rental Car Center in the Southwest Service Area was certified at the LEED Gold level and the Green Bus Depot was certified at the LEED Silver level.

Progress on the EMP should be incorporated into subsequent EDRs and ESPRs. A-25

Climate Change

Massport assets including Logan Airport are critical elements of the State's infrastructure and economy. As recognized in Governor Baker's recent Executive Order 569 "Establishing an Integrated Climate Change Strategy for the Commonwealth" and a suite of other state and municipal initiatives, the impacts of climate change must be an important consideration for development across the state. The EO

indicates that climate change presents a serious threat to the environment and the Commonwealth's residents, communities and economy. It indicates that extreme weather events associated with climate change present a serious threat to public safety and the lives and property of our residences. In addition, it indicates that the transportation sector continues to be a significant contributor to GHG emissions in the Commonwealth and is the only sector in which GHG emissions are increasing.

The 2015 EDR contains a greenhouse gas (GHG) emissions inventory for Logan Airport. Data is presented in units of million metric tons. It indicates that, in 2015, total GHG emissions grew by 6 percent due to aircraft operations and taxi times. Analysis of emissions has been expanded from a focus on direct sources associated with Massport assets and facilities to incorporate emissions associated with tenants and transportation and include indirect emissions for all sources.

Massport has indicated that it will continue to report on GHG emissions in 2016 and will
quantify aircraft, ground service equipment (GSE), motor vehicles and stationary sources using emission
factors and methodologies outlined in the EEA GHG Policy and the Transportation Research Board's A-26
Guidebook on Preparing Airport Greenhouse Gas Emissions Inventories (Airport Cooperative Research
Program (ACRP) Report 11, Project 02-06) and other relevant guidance. The expansion of GHG
reporting is significant and will guide Massport efforts to achieve sustainability goals and GHG
emission reduction goals. The presentation of the data could be improved, for instance, by normalizing
data and/or reporting emissions in several units (e.g. MMT and tpy) to allow comparisons between A-27
various programs, policies and reporting requirements. Massport controlled emissions and tenant
emissions, for instance, could be reported in kBtu/sf-yr by building for benchmarking purposes.
Identification of total GHG emissions associated with buildings and fuel sources would be informative. I A-28
encourage Massport to consider make this a focus for the 2016 ESPR. In addition, I encourage Massport
to consider establishment of aggressive goals for reducing GHG emissions, and in particular A-29
transportation emissions, in the 2016 ESPR. The ESPR should describe analysis methodologies and
assumptions to develop the 2016 ESPR emissions inventory and provide forecasts for 2035. The results A-30
should be compared to 2015.

In recognition of the potential effects of climate change on Massport infrastructure and operations, the Disaster and Infrastructure Resiliency Planning (DIRP) Study was initiated. A particular concern for Massport is the effect of sea level rise and projected increases in the severity and frequency of storms. The Study includes Logan Airport, the Port of Boston, and Massport's waterfront assets in South and East Boston. The DIRP Study includes a hazard analysis; modeling of projected sea-level rise and storm surge; and, temperature and precipitation projections and anticipated increases in extreme weather events. The study is nearing completion. I note that information from the Study has been incorporated into project-specific reviews. The 2016 ESPR should provide a summary of the DIRP Study and identify which recommendations Massport will implement in the short term to increase the resiliency of its facilities to the potential effects of climate change. A-31

<u>Mitigation</u>

The 2015 EDR identifies the status of mitigation commitments for specific Massport and tenant
projects at Logan Airport that have undergone MEPA review. The 2016 ESPR and future EDRs will A-32
continue to be the forum to address cumulative, Airport-wide impacts. The 2016 ESPR should update A-33

the status of Massport's mitigation commitments for the Terminal E Modernization Project and report on projects previously included in the EDRs. A-33 Cont.

<u>Planning</u>

The Airport Planning section describes the status of projects underway or completed at Logan Airport by the end of 2015 and provides updates for projects in progress. Specific topics include terminal area projects, service area projects, buffer/open space projects, Airport parking projects, airside area projects, high occupancy vehicle (HOV) improvements, and Airport-wide projects. It also describes known future planning, construction, and permitting activities.

It includes the following Airport Projects:

- *Terminal E Renovation and Enhancements Project*: This project includes interior and exterior improvements at Terminal E to accommodate regular service by wider and longer Group VI aircraft. The project does not include any new gates, but will reconfigure three existing gates to accommodate Group VI aircraft (including the Airbus A380 and Boeing 747-8 primarily used by international air carriers). An addition to the west side of Terminal E will allow passenger holdrooms to be reconfigured to accommodate the larger passenger loads associated with larger aircraft. The project also includes modifications to the airfield to meet required FAA safety and design standards to accommodate the larger aircraft. Construction commenced in 2015.

- *Terminal E Modernization Project*: This is proposed to accommodate existing and long range forecasted demand for international service. The expansion will add the three contact gates approved in 1996 as part of the International Gateway West Concourse project (EEA #9791), which were never constructed, and an additional two to four additional new gates in an extended concourse. A key feature of this project is the first direct pedestrian connection from the MBTA Blue Line Airport Station to the terminal complex at Logan Airport. It will also include improvements to Airport roadways to facilitate access. The project underwent MEPA review in 2016. Massport intends to commence construction prior to 2018.

- *Terminal C to E Connector:* The Terminal C to E Connector provides a new post-security connection between Terminals C and E on the Departures Level. Approximately 18,900 sf were made to the existing building, and 3,500 sf of new exterior construction. The connector provides improved passenger circulation within the post-security concourses, additional holdroom space at Terminal E, reconfigured office space, concessions and concessions support, and a new consolidated location for escalators and stairs. The project was completed in May 2016.

  Terminal B Airline Optimization Project: Massport is upgrading its facilities on the Pier B side of Terminal B to meet airlines' needs (primarily reflecting the merger of American Airlines and US Airways) and to provide facilities that improve the passenger traveling experience. Similar improvements have been implemented with the recent renovations and improvements at Terminal B, Pier A. Planned improvements include an enlarged ticketing hall, improved outbound bag area, expanded bag claim hall, expanded concession areas, and expanded holdroom capacity at the gate.

The 2016 ESPR should continue to assess planning strategies for improving Logan Airport's operations and services in a safe, secure, more efficient, and environmentally sensitive manner. As owner and operator of Logan Airport, Massport must accommodate and guide tenant development. The ESPR should describe the status of planning initiatives for the following areas: A-34

- Roadways and Airport Parking;
- Terminal Area;
- Airside Area;
- Service and Cargo Areas; and
- Airport Buffers and Landscaping.

The 2016 ESPR should also indicate the status of long-range planning activities, including the status of public works projects implemented by other agencies within the boundaries of Logan Airport. A-35 The ESPR should also indicate the status and effectiveness of ground access changes, including roadway and parking projects, that consolidate and direct airport-related traffic to centralized locations and minimize airport-related traffic on streets in adjacent neighborhoods. A-36

Regional Transportation

The 2015 EDR describes activity levels at New England's regional airports in 2015 and provides an update on regional planning activities, including long-range transportation efforts. The New England region is anchored by Logan Airport and a system of 10 other commercial service, reliever, and general aviation (GA) airports (regional airports). Overall, passenger traffic at the New England airports in 2015 represented the highest passenger traffic level for the region since the economic downturn in 2008 and exceeding the historical peak of 48.0 million in 2005. The increase in the region's passenger traffic was largely driven by continued growth at Logan Airport. In 2015, the total number of air passengers utilizing New England's commercial service airports, including Logan Airport, increased by 4.1 percent from 46.8 million annual air passengers in 2014 to 48.7 million in 2015. Of the 48.7 million passengers using New England's commercial service airports in 2015, 68.6 percent of passengers (33.4 million) used Logan Airport compared to 67.6 percent (31.6 million) in 2014. While passenger activity levels have increased, aircraft operations in the New England region remained flat in 2015, increasing 0.3 percent from 987,652 operations in 2014 to 991,041 operations in 2015. The 2016 ESPR should report on the issues identified below.

Regional Airports

- 2016 regional airport operations, passenger activity levels, and schedule data within an historical context;
- Status of plans and new improvements as provided by the regional airport authorities; A-37
- Role of the Worcester Regional Airport and Hanscom Field in the regional aviation system and Massport's efforts to promote these airports; and
- Ground access improvements at Massachusetts Regional Airport.

Regional Transportation System

- Massport's role in managing the regional transportation facilities within MassDOT;
- Massport's cooperation with other transportation agencies to promote efficient regional highway and transit operations; and A-38

- Report on metropolitan and regional rail initiatives and ridership. A-38 Cont.

Ground Access to and from Logan Airport

The 2015 EDR reports on transit ridership, roadways, traffic volumes, and parking for 2015. Massport continues to be in full compliance with the Logan Airport Parking Freeze regulations (310 Code of Massachusetts Regulations 7.30) which regulates the number of commercial and employee parking spaces allowed at Logan Airport (total limit of 21,088). The Parking Freeze is included in the Massachusetts State Implementation Plan (SIP) to achieve compliance with the Clean Air Act (42 U.S.C. §7401 et seq. [1970]). Massport submits semi-annual compliance filings to MassDEP; March and September reports are provided in the 2015 EDR. As permitted (and encouraged) by the Parking Freeze provisions, Massport has converted employee spaces to commercial spaces, within the overall limits.

The EDR states that Massport has continued to invest in and operate Logan Airport with a goal of increasing the number of passengers arriving by transit or other high occupancy vehicle (HOV) modes. The HOV/transit mode share at Logan Airport continues to rank at the top of U.S. airports. The 2015 EDR identifies improvements to increase HOV/transit mode share including introduction of the Back Bay Logan Express pilot service (since May 2014); free boardings from Logan Airport to the MBTA Silver Line outbound; construction of a 1,100-car parking garage at the Framingham Logan Express; reduced holiday travel parking rates at Logan Express facilities; increased parking rates on the Airport; and support for private coach bus and van operators.

As part of its Long-Term Parking Management Plan, Massport is considering a series of measures to minimize pick-up/drop-off activity. The EDR indicates that the increase in terminal area parking rates since July 1, 2014 described in the 2014 EDR, does not seem to be have influenced parking demand; daily parking demand more frequently approached the Parking Freeze cap in 2015. The 2015 EDR identifies a proposal to build up to 5,000 new on-Airport commercial parking spaces. Massport states that the goal of the project is to reduce the number of drop-off/pick-up mode which generate more traffic than parking. The construction of additional commercial parking spaces is dependent upon amending the Parking Freeze legislation. Massport has initiated a stakeholder process prior to proposing any amendments and Massport anticipates initiating a parallel review process.

The Airport-wide Automated Traffic Monitoring System (ATMS) consists of permanent traffic count stations at the Airport's gateway roadways, including the Route 1A roadway ramps, the Interstate-90 (I-90) Ted Williams Tunnel ramps, and Frankfort Street/Neptune Road. These stations provide data on annual average daily traffic (AADT), annual average weekday daily traffic (AWDT), and annual average weekend daily traffic (AWEDT). The AADT increased by 0.1 percent between 2014 and 2015. The change in average daily traffic can be attributed to: a 5.7-percent increase in air passenger activity in 2015; a 3.0-percent increase in taxi dispatches in 2015; and 1.1-percent decrease in parking activity (exits) in 2015. Historically, the highest AADT recorded at Logan Airport was in 2007, when AADT reached 110,690, AWDT was 119,200, and AWEDT was 91,320 that same year. These gateway traffic volumes corresponded to an annual air passenger level of 28,102,455 passengers.

On-Airport vehicle miles of travel (VMT) is calculated based on the total number of miles traveled by all vehicles within the Logan Airport roadway system and is used to calculate motor vehicle air emissions. Massport upgraded its modeling capabilities in 2011 and began using an on-Airport VISSIM-10 model which is more robust than the previous model. The adjustment factors for the 2015

VMT calculations were determined by using 2011 to 2015 gateway, Airport roadway, and parking volume averages.

Based on the traffic data obtained from Massport's ATMS, the change in on-Airport daily traffic volumes between 2014 and 2015 was negligible. However, 2015 evening peak hour gateway volumes grew by roughly 5 percent when compared to 2014. Additionally, a shift in gateway traffic entering/exiting the Airport from the Ted Williams Tunnel to the Sumner/Callahan Tunnels was noted. Daily traffic volumes in the Ted Williams Tunnel decreased by 8.4 percent (from 49,600 to 45,400 vehicles) while volumes in the Sumner/Callahan Tunnels increased by 19.5 percent (from 29,800 to 35,600 vehicles). Since 2000, the highest average weekday VMT estimated at Logan Airport was in 2007, when weekday VMT was modeled at 184,613. Although VMT was estimated at lower levels in 2015, a direct comparison between values cannot be made because of significant changes in the study area.

The 2016 ESPR should report on 2016 ground access conditions at the airport and provide a comparison of 2016 findings to those of 2015 for the following:

- Detailed description of compliance with Logan Airport Parking Freeze;
- HOV ridership (including Blue Line, Silver Line, Water Transportation, and Logan Express);
- Logan Airport Employee Transportation Management Association (Logan TMA) services;
- Logan Airport gateway volumes;
- On-airport traffic volumes;
- On-airport VMT;
- Parking demand and management (including rates and duration statistics);
- Status of long-range ground access management strategy planning;
- Results of the 2016 Logan Airport Air Passenger Survey; and,
- Status of proposed connector to the Airport Station associated with the planned Terminal E Modernization Project.

A-39

The chapter should present a discussion of analytical methodologies and assumptions for the planning horizon year (2035) for traffic volumes, on-airport VMT and parking demand.

A-40

The 2016 ESPR should address the following topics:

- Massport's target HOV mode share along with incentives;
- Non-Airport through-traffic;
- Massport's cooperation with other transportation agencies to increase transit ridership to and from Logan Airport via the Blue Line, Silver Line, Water Transportation, and Logan Express;
- Efforts to increase capacity and usage of Logan Express;
- Progress on enhancing water transportation to and from Logan Airport;
- Report on results of ground access study; and
- Strategies for enhancing services and increasing employee membership in the TMA.

A-41

Noise

The 2015 EDR updates the status of the noise environment at Logan Airport in 2015, and describes Massport's efforts to mitigate noise exposure and impacts. As noted previously, the implementation of RNAV has resulted in concentration of flight patterns over certain communities and significant increases in noise exposure. Noise complaints have increased from 12,855 calls in 2014 to 17,685 calls in 2015. In addition, the FAA introduced the AEDT, a new model for noise and air quality. Massport did not submit AEDT modeling results and, instead, modeled noise using the FAA's Integrated Noise Model (INM) as in previous years. Massport intends to use the AEDT for noise modeling for the 2016 ESPR if the adjustments are approved by the FAA. Massport should update the MEPA office regarding the status of the requested adjustments and consult with the MEPA office regarding ESPR noise modeling as early as possible if the FAA does not approve use of the requested adjustments or it appears that the FAA review will be delayed. I note comments that indicate data should be provided regardless of FAA's approval or timing. Otherwise, noise contours for 2016 should be developed using AEDT and compared to the most recent version of the Integrated Noise Model (INM) which has been in place for all previous EDRs and ESPRs. Logan Airport-specific model adjustments made to account for over-water sound propagation and the propagation of sound to areas of higher terrain may be reported as an add-on to AEDT, if accepted by the FAA.

A-42

A-43

Compared to 2000, the 2015 EDR indicates that total operations were down by 23.6 percent while total passengers were up by 20.6 percent; that the percentage of jet operations increased to 86 percent from 66 percent; and the number of people exposed to Day-Night Average Sound Level (DNL) 65 decibels (dB) has declined by 20.6 percent.

Compared to 2014, the 2015 DNL 65 dB noise contours were larger in most areas around the Airport due to changes in: (1) runway usage, primarily as a result of wind and weather conditions, (2) a 5.7% increase in the number of nighttime operations, and (3) an increase in the number of overall operations. The overall number of people exposed to DNL values greater than or equal to 65 dB increased by 58.0 percent, from 8,922 people in 2014 to 14,097 people in 2015. This increase is a significant concern to residents, as clearly indicated in comment letters, and to Massport.

Runway use changes from 2014 to 2015 were the largest factor in the increase in the number of people exposed to DNL values greater than or equal to 65 dB in 2015 which is a significant issues raised in many comments. The DNL contour increased in East Boston and slightly in South Boston due to an increase in Runway 22R departures. The DNL contour in Winthrop increased because departures from Runway 22L increased. Increased nighttime arrivals to Runways 22L and 27 contributed to increases in Revere and Winthrop. Data from 2015 reflects almost a full year of the head-to-head night noise abatement procedures on Runway 15R-33L. While this reduces overall noise exposure by concentrating operations over water rather than over populated areas, it increases start-of-takeoff-roll noise in East Boston, north and west of the Runway 15R end. Decreased use of Runway 4R for arrivals in 2015 resulted in a reduction in the contour south of the Airport.

Nighttime operations increased from 48,056 to 50,786 in 2015. The increase remains below the peak of 54,038 annual operations at night reached in 1999; however, this growth is significant and a particular concern given the extent and concentration of noise exposure. As airlines have expanded to

new destinations, the number of commercial operations, and in turn the number of nighttime operations, has increased. In 2015, there was an increase of 7.5 nighttime operations per day compared to 2014.

The overall increase in operations was smaller than the increase in nighttime operations (2.5 percent overall versus 5.7 percent nighttime), but contributed to the expansion of the noise contours. The DNL and population levels in 2015 remain well below the peak levels reached in 1990 and are less than in the year 2000 when 17,745 people were exposed to DNL levels greater than or equal to DNL 65 dB. The 2015 DNL 65 dB contour is somewhat larger than the 2014 DNL 65 dB contour. Almost all of the residences exposed to levels greater than or equal to DNL 65 dB in 2015 have been eligible in the past to participate in Massport's residential sound insulation program (RSIP). To date, Massport has provided sound insulation for a total of 11,515 residential units, and will continue to seek funding for sound insulation for properties that are eligible and whose owners have chosen to participate.

The 2016 ESPR should provide an overview of the environmental regulatory framework affecting aircraft noise, the changes in aircraft noise, and the updates in noise modeling. The chapter should report on 2016 conditions and compare those conditions to those of 2015 for the following:

- Fleet Mix, including Stage II, Recertified Stage III, newly manufactured Stage III, and qualifying Stage IV aircraft;
- Nighttime operations;
- Runway utilization (report on aircraft and airline adherence with runway utilization goals); and
- Flight tracks.

A-44

The 2016 ESPR should report on the following:

- Changes in annual noise contours and noise-impacted population;
- Measured versus modeled noise values, including reasons for differences and any improvements attributable to the models deployed;
- Cumulative Noise Index (CNI);
- Times-Above for 65, 75, and 85 dBA threshold values/Dwell and Persistence of noise levels; and
- Flight track monitoring noise reports.

A-45

The 2016 EDR should also report on consultation between Massport and FAA regarding the impacts of RNAV, noise abatement efforts, results of Boston Logan Airport Noise Study (BLANS) study, and provide an update on the noise and operations monitoring system. A-46

Air Quality/Emissions Reduction

The 2015 EDR provides an overview of airport-related air quality issues in 2015 and efforts to reduce emissions. The air quality modeling reported in 2015 EDR is based on aircraft operations, fleet mix characteristics, airfield taxiing times, GSE usage, motor vehicle traffic volumes, and stationary source utilization rates. Total air quality emissions from all sources associated with Logan Airport in 2015 are significantly less than they were a decade ago.

In 2015, calculated emissions of volatile organic compounds (VOCs), oxides of nitrogen (NOx), carbon monoxide (CO), and particulate matter (PM) went up slightly compared to 2014. The increase is

primarily due to the increase in aircraft landing and take offs (LTOs) and airfield taxi times. Total emissions of VOCs increased by 1 percent in 2015 to 1,188 kilograms (kg)/day compared to 1,177 kg/day in 2014. Total NOx emissions increased by approximately 5 percent in 2015, to 4,262 kg/day compared to 2014 levels of 4,040 kg/day. Massport's voluntary Air Quality Initiative (AQI) has tracked NOx emissions since the benchmark year of 1999. In the final year of this program (2015), total NOx emissions were 632 tons per year (tpy) lower than the 1999 benchmark. This represents an overall decrease of 27 percent in NOx emissions over the past 15 years. Between 1999 and 2015, the greatest reductions of NOx emissions were associated with aircraft, GSE, and on-Airport motor vehicles at 17 percent, 71 percent, and 87 percent reductions, respectively. Total CO emissions increased by about 3.5 percent in 2015 to 7,243 kg/day, from 6,987 kg/day in 2014; emissions in 2015 were still well below 1990 and 2000 levels. Total PM10/PM2.5 emissions also increased by about 3 percent in 2015 to 98 kg/day, from 95 kg/day in 2014.

The ESPR should contain an overview of the environmental regulatory framework affecting aircraft emissions, changes in aircraft emissions, changes in air quality modeling and air quality studies. A-47
The ESPR should also provide discussion on progress on the national and international levels to decrease air emissions, including alternative fuel vehicle programs implemented by Massport and/or its tenants. A-48
If the AEDT tool is used for modeling the 2016 ESPR should compare results to the most recent version of the Emissions Dispersion Modeling System (EDMS) that has been used in recent EDR filings. The Environmental Protection Agency (EPA) MOVES2014a program will continue to be used to estimate vehicular emission on airport roadways. A-49
The ESPR should include an emissions inventory for CO, NOx, VOCs, and PMs. A-50

Commenters express concern that the EDR does not provide a substantive response to concerns expressed regarding ultrafine particulates (UFP). As commenters are aware, UFPs are not regulated by the US Environmental Protection Agency (EPA) and EPA has not proposed to adopt standards for UFPs. I encourage Massport to consider how the ESPR might constructively address the concern presented by commenters. The ESPR should specifically identify any ongoing or new policies or programs that would reduce diesel emissions. A-51

The ESPR should include an update on its efforts to encourage the use of single engine taxiing under safe conditions and, A-52
as required in the review of the Terminal E Expansion, Massport should report on progress made in designing the energy systems for the facility and the feasibility of combined heat and power (CHP). A-53

Water Quality/Environmental Compliance

The 2015 EDR describes Massport's ongoing environmental management activities including National Pollutant Discharge Elimination System (NPDES) compliance, stormwater, fuel spills, activities under the Massachusetts Contingency Plan (MCP), and tank management. Massport's primary water quality goal is to prevent or minimize pollutant discharges, thus limiting adverse water quality impacts of airport activities. Massport employs several programs to promote awareness of activities that may impact surface and groundwater quality. Programs include implementing best management practices (BMPs) for pollution prevention by Massport, its tenants, and its construction contractors; training of staff and tenants; and a comprehensive stormwater pollution prevention plan. The EDR reports that Massport continues to comply with water quality and other environmental regulations.

The 2016 ESPR should identify any planned stormwater management improvements and report on the status of: A-54

- NPDES Permit and monitoring results for Logan Airport's outfalls and the Fire Training Facility;
- Jet fuel usage and spills;
- MCP activities;
- Tank management;
- Environmental management plan; and
- Fuel spill prevention.

Conclusion

I have determined that the 2015 EDR for Logan Airport has adequately complied with MEPA. The EDR provides a comprehensive overview of environmental planning, issues and data. Massport may prepare the 2016 ESPR for submission in 2017 consistent with the Scope included in this Certificate.

February 17, 2017
Date

Matthew A. Beaton

Comments received:

01/18/2017	Logan CAC
01/20/2017	Nancy Timmerman
01/20/2017	Stephen Kaiser
01/20/2017	Boston Harbor Now
01/31/2017	Brian Palmucci, Quincy City Council
01/31/2017	Aaron Toffler, Airport Impact Relief, Inc.
01/31/2017	Chris Marchi
01/31/2017	Wig Zamore
02/01/2017	Bill Schmidt
02/01/2017	Cindy L. Christiansen
02/01/2017	James Roberts
02/01/2017	James Linthwaite
02/01/2017	Town of Milton Office of Selectmen
02/02/2017	John Antonellis
02/17/2017	U.S. Senator Elizabeth Warren

MAB/ACC/acc

The Commonwealth of Massachusetts
Executive Office of Energy and Environmental Affairs
100 Cambridge Street, Suite 900
Boston, MA 02114

Charles D. Baker
GOVERNOR

Karyn E. Polito
LIEUTENANT GOVERNOR

Matthew A. Beaton
SECRETARY

Tel: (617) 626-1000
Fax: (617) 626-1181
http://www.mass.gov/envir

November 13, 2015

CERTIFICATE OF THE SECRETARY OF ENERGY AND ENVIRONMENTAL AFFAIRS
ON THE
2014 LOGAN AIRPORT ENVIRONMENTAL DATA REPORT

PROJECT NAME	: 2014 Environmental Data Report
PROJECT MUNICIPALITY	: Boston/Winthrop
PROJECT WATERSHED	: Boston Harbor
EOEA NUMBER	: 3247
PROJECT PROPONENT	: Massachusetts Port Authority
DATE NOTICED IN MONITOR	: October 7, 2015

As Secretary of Executive Office of Energy and Environmental Affairs (EEA), I hereby determine that the Environmental Data Report submitted on this project **adequately and properly complies** with the Massachusetts Environmental Policy Act (MEPA) (M.G.L. c. 30, ss. 61-62I) and with its implementing regulations (301 CMR 11.00).

Background

The environmental review process for Logan Airport has been structured to occur on two levels: airport-wide and project-specific. The Environmental Status and Planning Report (ESPR) has evolved from a largely retrospective status report on airport operations to a broader analysis that also provides a prospective assessment of long-range plans. It has thus become, consistent with the objectives of the MEPA regulations, part of the Massachusetts Port Authority's (Massport) long-range planning process. The ESPR provides a "big picture" analysis of the environmental impacts of current and anticipated levels of activities, and presents an overall strategy to minimize impacts. The ESPR is supplemented by (and ultimately incorporates) the detailed analyses and mitigation commitments for project-specific Environmental Impact

Reports (EIR). The ESPR is generally updated on a five-year basis; the most recent ESPR for the year 2011 was filed in April of 2013. Environmental Data Reports (EDRs) (formerly referred to as Annual Updates) are filed in the years between ESPRs.

The EDRs are prepared annually to evaluate environmental conditions for the reporting year compared to the previous year. In the last several years, aircraft operations and passenger activity levels and associated environmental effects have remained well below levels previously analyzed for Logan Airport. Thus, the forecasted aviation growth presented in the 2004 ESPR, the predicate upon which the ESPR schedule was initially established, has not occurred. Accordingly, with the approval of the Secretary of Energy and Environmental Affairs, Massport prepared 2009 and 2010 EDRs in lieu of the ESPR originally planned for 2009. The 2011 ESPR, filed in early 2013, reported on calendar year 2011 passenger activity levels and aircraft operations forecasts. The 2012/2013 EDR presented conditions for both calendar years 2012 and 2013.

The 2014 EDR is the subject of this review. Additionally, this Certificate contains a Scope for the 2015 EDR. This 2014 EDR provides a comprehensive, cumulative analysis of the effects of all Logan Airport activities based on actual passenger activity and aircraft operational levels in 2014 and presents environmental management plans for addressing areas of environmental concern. It also reports on the status of project mitigation. The next anticipated ESPR will report on updated passenger activity levels, aircraft operations forecasts, and environmental conditions forecasts for 2016.

Passenger levels at Logan Airport reached a new peak in 2013, exceeding the 2007 historic peak, while aircraft operations at Logan Airport remained well below the historic peak reached in 1998. The 2014 EDR examines the effects of airlines operating much more efficiently with quieter fleets and flying more passengers per aircraft. As discussed in the 2011 ESPR, the 2014 EDR anticipates further increases in activity levels and some increases in environmental impacts compared to recent years; however, these will remain below levels projected in 2004.

Scope for the 2015 EDR

General

The 2015 EDR should follow the general format of the 2014 EDR. The 2015 EDR should include an Executive Summary and Introduction. To provide context for reviewing agencies and the public, it should provide background information on the environmental policies and planning that shape the environmental reporting, technical studies, and environmental mitigation initiatives at Logan Airport. A-1

The 2015 EDR should provide an update on conditions at Logan Airport for calendar year 2014, including passenger and aircraft operation activity levels. It should continue to serve as a background/context against which projects at Logan Airport can be evaluated. It should also report on the cumulative effects of Logan Airport operations and activities, compared to previous A-2

years, as appropriate. It should provide a status report on Massport's proposed planning initiatives, projects, and mitigation measures. A-2 Cont.

The technical studies in the 2015 EDR should include reporting on and analysis of key indicators of airport activity levels, the regional transportation system, ground access, noise, air quality, environmental management, and project mitigation tracking. The 2015 EDR must also respond to those issues explicitly noted in this Certificate and the comments received on the 2014 EDR. A-3

A distribution list for the 2015 EDR (indicating those receiving documents, CDs, or Notices of Availability) should be provided in the document. This section must also include copies of all ESPR and EDR Certificates issued since the 2011 Logan ESPR to provide context for reviewers. Supporting technical appendices should be provided as necessary. A-4

Responses to Comments

The 2015 EDR Responses to Comments should address all of the substantive comments from the letters listed at the end of this Certificate. The Responses to Comments included in the 2014 EDR is well-constructed and cross-referenced. I encourage Massport to use the same format in the 2015 EDR. A-5

The majority of comments received on the 2014 EDR focus on noise issues, including measurement of noise, modeling of noise contours, and noise abatement, and emissions reduction issues. In addition to responding to these comments, the 2015 EDR should continue to report on the refinements to noise tracking and abatement efforts. Massport should consult directly with individual commenters where appropriate. A-6

Activity Levels

The Activity Levels chapter provides a solid analysis of major activity issues and the technical appendix contains useful and detailed information. This chapter presents aviation activity statistics for Logan Airport in 2014. Logan Airport is New England's primary domestic and international airport, operating as an origin-destination airport, rather than a connecting hub for major airlines. The total number of air passengers increased by 4.7 percent to 31.6 million in 2014, compared to 30.2 million in 2013. The 2014 passenger level represents a new record high for Logan Airport.

Passenger-aircraft operations accounted for 91 percent of total aircraft operations. The total number of aircraft operations increased slightly from approximately 361,339 in 2013 to 363,797 in 2014, a 0.7 percent increase. This was preceded by a 2.4 percent increase in 2013. Despite the increase, aircraft operations at Logan Airport remained well below the 487,996 operations in 2000 and the historic peak achieved in 1998. In 1986, Logan Airport served 21.7 million air passengers, as compared to 31.6 million in 2014 with roughly the same number of total operations (363,995).

Aircraft efficiency continued to improve in 2014 as the average number of passengers per aircraft operation grew from 83.6 in 2013 to 87.0 in 2014. This positive trend is indicative of the industry-wide shift toward higher aircraft load factors and an increase in the number of domestic and international destinations. While the number of domestic and international passengers is increasing, international passenger demand is projected to increase at a faster rate than domestic passenger demand. Total international annual passenger numbers increased from 4.4 million in 2013 to 4.9 million in 2014, a 9.8-percent increase. The strong international passenger growth was driven by several new nonstop services introduced by a number of foreign airlines including Emirates, Turkish Airlines, Hainan Airlines, and Cathay Pacific. Recently launched international destinations include Mexico City, Tokyo, Beijing, Dubai, Istanbul, Panama City, Hong Kong, and Shanghai. International air passengers are anticipated to reach 6 million by 2022 and 8 million by 2030.

The 2015 EDR should report on airport activity levels and aircraft operations, including: A-7

- Aircraft operations, including fleet mix and scheduled airline services at Logan Airport;
- Passenger activity levels;
- Cargo and mail activities;
- Compare 2014 aircraft operations, cargo/mail operations, and passenger activity levels to 2013 activity levels; and
- Report on national aviation trends in 2014 and compare to trends at Logan Airport.

It should also report on Massport's activity level forecasts that will become the basis for the planning and impact sections that follow and for Massport's strategic planning initiatives for the future ESPR. Massport should address comments related to activity levels in the 2015 EDR. A-8

Sustainability at Logan Airport

The 2014 EDR describes Massport's airport wide sustainability goals. In October 2000, the Massport Board approved an Environmental Management Policy, which articulates Massport's commitment to protect the environment and to implement sustainable design principles. In 2013, Massport was awarded a grant by the Federal Aviation Administration (FAA) to prepare a Sustainability Management Plan (SMP) for Logan Airport. The purpose of the SMP is to enhance the efficiency and sustainability of Logan Airport's operations and to support the broader sustainability principles of the Commonweath. The Logan Airport SMP planning effort began in May 2013 and was completed in April 2015. The plan is intended to promote and integrate sustainability Airport-wide and to coordinate ongoing sustainability efforts at Massport. A baseline data assessment was completed in winter 2014 to assess current sustainability performance at the Airport. The Logan Airport SMP developed a framework and implementation plan, with metrics and targets, designed to track progress over time.

The 2014 EDR provides an excellent overview of Massport's commitment to incorporate sustainability into all aspects of Massport's activities: Planning and Design; Construction; Operations, Maintenance and Management; and Monitoring of Environmental Performance. It also identifies specific practices to reduce impacts of construction and efforts to address energy intensity, percentage of renewable energy, and GHG reductions. The SMP establishes goals for

ten categories: Energy and Greenhouse Gases; Water Conservation; Community, Employee, and Passenger Well-being; Materials, Waste Management, and Recycling; Resiliency; Noise Abatement; Air Quality Improvement; Ground Access and Connectivity; Water Quality/Stormwater; and Natural Resources.

A specific example includes compliance with the Leading by Example Executive Order which requires state agencies to procure 15 percent of their electricity from renewable resources by 2012. The Leading by Example program has influenced Massport's own operations including its offices, heating plants, and garages resulting in Massport receiving the Leading by Example award in 2008. Massport is striving to achieve LEED certification for new and substantial rehabilitation of building projects over 20,000 square feet. Some recent examples of LEED certified buildings at Logan Airport. The new Rental Car Center in the Southwest Service Area (SWSA) began construction in 2010 and was completed in 2013and was awarded Logan Airport's first LEED Gold Certification in 2015.

I commend Massport for its commitment to sustainability and its leadership. Progress on the SMP should be incorporated into subsequent EDRs and ESPRs. The 2015 EDR should report on the progress towards each of the ten goals and sustainability-related performance. A-9

The 2015 EDR should report on the status of mitigation commitments for specific Massport and tenant projects at Logan Airport that have undergone MEPA review, including whether they are under construction or completed. The status of mitigation commitments made in the Section 61 Findings for the following projects should be included: A-10

- West Garage/Central Garage (EEA #9790)
- International Gateway (EEA #9791)
- Logan Airside Improvements Planning Project (EEA #10458)
- Terminal A Replacement Project (EEA #12096)
- Southwest Service Area Redevelopment Program/Rental Car Center (EEA #14137)
- Logan Runway Safety Area Improvements Project (EEA #14442)

Planning

The Airport Planning chapter in the 2014 EDR provides an overview of planning, construction, and permitting activities that occurred at Logan Airport in 2014. It also describes future planning, construction, and permitting activities and initiatives. It includes the following Airport Projects:

- *Parking Consolidation Project*: Massport is consolidating 2,050 temporary parking spaces as an addition to the West Garage and at the existing surface lot between the Logan Office Center and the Harborside Hyatt. These spaces constitute all the remaining spaces permitted under the Logan Airport Parking Freeze. The West Garage addition is atop the existing Hilton Hotel parking lot. The project will incorporate sustainable design and resiliency elements. The consolidation is expected to be completed in 2015.
- *Terminal E Renovation and Enhancements Project*: This project includes interior and exterior improvements at Terminal E to accommodate regular service by wider and

longer Group VI aircraft. The project does not include any new gates, but will reconfigure three existing gates to accommodate Group VI aircraft (including the Airbus A380 and Boeing 747-8 primarily used by international air carriers). An addition to the west side of Terminal E will allow passenger holdrooms to be reconfigured to accommodate the larger passenger loads associated with larger aircraft. The project also includes modifications to the airfield to meet required Federal Aviation Administration (FAA) safety and design standards to accommodate the larger aircraft. An Environmental Assessment (EA) was filed and FAA issued a Finding of No Significant Impact (FONSI) on July 29, 2015. Construction commenced in 2015.
- *Terminal E Modernization Project*: To accommodate existing and long range forecasted demand for international service in an efficient, environmentally-sound manner that also improves customer service, Massport is planning to expand Terminal E. Modernizing Terminal E would add the three contact gates approved in 1996 as part of the International Gateway West Concourse project (EEA #9791), which were never constructed, and an additional two to four additional new gates in an extended concourse. A key feature of this project is the first direct pedestrian connection from the MBTA Blue Line Airport Station to the terminal complex at Logan Airport. This project would also include improvements to Airport roadways to facilitate access. The project is in the conceptual design phase. Massport intends to commence construction prior to 2018. An Environmental Notification Form (ENF) for this project (EEA#15434) was published in the November 9 Environmental Monitor.
- *Logan Airport Greenway Connector Project:* The Logan Airport Greenway Connector ("Greenway Connector") is a pedestrian/bicycle path connecting the Bremen Street Park path to the future City of Boston Narrow Gauge Connector, a pedestrian/bicycle path that begins at the Greenway Overlook and continues to Constitution Beach. Construction of the Greenway Connector began in spring 2013 and was completed in July 2014.
- *The Rental Car Center (RCC)*: Consolidating the rental car shuttle bus fleet and some Massport shuttle buses into a unified shuttle route system resulted in the elimination of eight rental car bus fleets (a net total of 66 buses have been eliminated). It included intersection and roadway infrastructure improvements including signal coordination and dedicated ramp connections. It also created a Ground Transportation Operations Center (GTOC) to support efficient planning and operation of Airport-wide transit activities.

In recognition of the potential and significant effects of climate change on Massport infrastructure and operations, Massport has initiated the Disaster and Infrastructure Resiliency Planning (DIRP) Study. A particular concern for Massport is the effects of sea level rise and projected increases in the severity and frequency of storms. The Study includes Logan Airport, the Port of Boston, and Massport's waterfront assets in South and East Boston. The DIRP Study includes a hazard analysis; modeling of projected sea-level rise and storm surge; and, temperature and precipitation projections and anticipated increases in extreme weather events. The study is nearing completion. The 2015 EDR should provide a summary of the DIRP Study and identify which recommendations Massport will implement in the short term to increase the resiliency of its facilities to the potential effects of climate change. A-11

Massport is developing a long-term parking management plan for Logan Airport. The Long-Term Parking Management Plan will lay out a multi-part strategy for efficiently managing parking supply, pricing, and operations – both at Logan Airport and at off-Airport locations controlled by Massport – to maximize access for transit and shared-ride vehicles while minimizing both drive-and-park and pick-up/drop-off modes. The 2015 EDR should provide updates on this plan. A-12

The 2015 EDR should also report on Massport planning to improve Logan Airport's operations and services in a safe, secure, more efficient, and environmentally sensitive manner. As owner and operator of Logan Airport, Massport also must accommodate and guide tenant development. Specifically, the 2015 EDR should also describe the status of planning initiatives for the following areas: A-13

- Roadway Corridor Project;
- Airport Parking;
- Terminal Area;
- Airside Area;
- Service and Cargo Areas; and
- Airport Buffers and Landscaping.

The 2015 EDR should provide a status report on long-range planning activities. This chapter should include the status and effectiveness of the ground access changes, including roadway and parking projects, that will consolidate and direct airport-related traffic to centralized locations and minimize airport-related traffic on external streets in adjacent neighborhoods. A-14

Regional Transportation

The 2014 EDR describes activity levels at New England's regional airports in 2014 and provides an update on regional planning activities, including long-range transportation efforts. The New England region is anchored by Logan Airport and a system of 10 other commercial service, reliever, and general aviation (GA) airports (regional airports). Overall, passenger traffic at the New England airports in 2014 represented the highest passenger traffic level for the region since the economic downturn in 2008. The increase in the region's passenger traffic was largely driven by continued growth at Logan Airport. In 2014, the total number of air passengers utilizing New England's commercial service airports, including Logan Airport, increased by 3.1 percent from 45.4 million in 2013 to 46.8 million annual air passengers in 2014. Of the 46.8 million passengers using New England's commercial service airports in 2014, 67.6 percent of passengers (31.6 million) used Logan Airport compared to 66.6 percent (30.2 million) in 2013. While passenger activity levels have increased, aircraft operations in the New England region have decreased. In 2014, regional aircraft operations decreased by 4.3 percent, from 1.02 million operations in 2013 to 0.97 million operations in 2014.

The 2015 EDR should describe Logan Airport's role in the region's intermodal transportation system by reporting on the following:

Regional Airports

- 2015 regional airport operations, passenger activity levels, and schedule data within an historical context;
- Status of plans and new improvements as provided by the regional airport authorities;
- Ground access improvements; and
- Role of the Worcester Regional Airport and Hanscom Field in the regional aviation system and Massport's efforts to promote these airports. A-15

Regional Transportation System

- Massport's role in managing the regional transportation facilities within MassDOT;
- Massport's cooperation with other transportation agencies to promote efficient regional highway and transit operations; and
- Report on metropolitan and regional rail initiatives and ridership.

Ground Access to and from Logan Airport

The 2014 EDR reports on transit ridership, roadways, traffic volumes, and parking for both 2012 and 2013. Specifically, the EDR states that Massport has continued to invest in and operate Logan Airport with a goal of increasing the number of passengers arriving by transit or other high occupancy vehicle (HOV) modes. The HOV/transit mode share at Logan Airport continues to rank at the top of U.S. airports. However, private passenger vehicle trips continue to increase with growth in air travel. As Logan Airport air traveler numbers have increased, a constrained parking supply at Logan Airport has resulted in an increase in pick-up and drop-off vehicle trips. These trips generate automobile emissions both locally and regionally. As part of its Long-Term Parking Management Plan, Massport is considering a series of measures to minimize pick-up/drop-off activity.

In 2014, Massport remained in full compliance with the Logan Airport Parking Freeze regulations. Despite an increase in terminal area parking rates on July 1, 2014, daily parking demand more frequently approached the Parking Freeze cap in 2014. Massport is consolidating 2,050 temporary parking spaces in addition to the West Garage and at the existing surface lot between the Logan Office Center and the Harborside Hyatt. These spaces constitute all remaining spaces permitted under the Logan Airport Parking Freeze. Increases in weekday peak commercial parking demand places additional pressure on roadway and parking operations under the Logan Airport Parking Freeze. In 2014, due to high demand on Tuesdays, Wednesdays, and Thursdays, 30,314 cars were diverted to another garage or lot and 56,634 cars were valeted/stacked (when cars are parked in aisles, have their keys taken, and then are re-parked in empty spaces as they become vacant); this represents over a 50 percent increase since 2013. There were about 40 weeks in which one or more of these measures were put into effect in 2014.

The 2015 EDR should report on the following and compare trends to 2014:

- Detailed description of compliance with Logan Airport Parking Freeze;
- High occupancy vehicle (HOV) ridership (including Blue Line, Silver Line, Water Transportation, and Logan Express);
- Massport's cooperation with other transportation agencies to increase transit ridership to and from Logan Airport via the Blue Line and Silver Line;
- Logan Airport Employee Transportation Management Association (Logan TMA) services;
- Logan Airport gateway volumes;
- On-airport traffic volumes;
- On-airport vehicle miles traveled (VMT);
- Parking demand and management (including rates and duration statistics);
- Status of long-range ground access management strategy planning; and
- Results of the 2015 Logan Airport Passenger Survey.
- Massport's target HOV mode share along with incentives; and,
- Non-Airport through-traffic;
- Report on Logan Express usage and efforts to increase capacity and usage;
- Report on water transportation to and from Logan Airport; and
- Report on results of ongoing ground access studies.

A-16

Noise Abatement

The 2014 EDR updates the status of the noise environment at Logan Airport in 2012 and 2013, and describes Massport's efforts to reduce noise levels. Many of the issues raised in the noise analysis are ongoing and require continuous monitoring. The 2015 EDR should address the noise issues raised by numerous commenters on the 2014 EDR.

A-17

In 2014, an additional 106 residential units received sound insulation bringing the program total to 11,515 residential units treated, amongst the highest in the nation. Since 2000, the number of daily aircraft operations has declined by almost 27 percent (from 1,355 operations per day in 2000 to 997 operations per day in 2014). This trend reflects an increase in the use of larger aircraft, airline consolidation, and increased efficiencies on the part of airlines. As described throughout this EDR, this evolution towards fewer flights with larger, more efficient and quieter aircraft has yielded substantial environmental benefits. Compared to 2000, in 2014:

- Jet operations made up 86 percent of operations compared to 66 percent;
- Overall operations were down by 25 percent while overall passengers were up by 14 percent; and
- The number of people exposed to DNL 65 dB has declined by 50 percent since 2000. Compared to 2013, the 2014 DNL 65 dB noise contours were larger in most areas around the Airport. The DNL contour was larger over East Boston, Winthrop, and Revere.

There were several temporary FAA- mandated airfield/airspace operating factors that influenced the contour changes in 2014. Due to safety concerns at airports across the US in June of 2014, the FAA temporarily halted the use of head-to-head operations or opposite direction operations, in which planes arrive on a runway in one direction and depart in the opposite direction. When in use at Logan Airport, the procedure has aircraft departing from Runway 15R and landing on Runway 33L during the late night (typically midnight to 5:00 AM) when weather conditions are appropriate, including good visibility and little wind. At Logan Airport, head-to-head operations are an important part of the use of the late night noise abatement runway (Runway 15R-33L) since this keeps operations over Boston Harbor. Use of this procedure was restored in early 2015. FAA also restricted the use of converging runways across the United States in January 2014 due to safety concerns. At Logan Airport, Runways 22L and 22R and Runway 27 were affected by this change. While Runway 22R is in use for departing aircraft, arrivals that would typically be directed to Runway 27 were sent by the FAA Air Traffic Control to arrive on Runway 22L. This restriction has since been lifted. Runway 15L-33R was closed for a short period of time (eight weeks) during the summer of 2014 for Runway Safety Area Improvements. This resulted in aircraft using Runway 15R-33L, Runway 4L, and Runway 22L more frequently in 2014 than in 2013. The construction activity also resulted in short closures of the intersecting Runway 4L-22R and Runway 4R-22L, which increased usage of Runway 15R-33L. An additional factor influencing the contour changes was an increase in overall operations and nighttime operations in 2014 compared to 2013. Nighttime operations increased for passenger flights as airlines expanded destinations and the number of flights per day. Several new international airlines began service at Logan Airport in 2014.

The information in the Noise Abatement chapter is very informative. I expect detailed analysis will be provided in the 2015 EDR and that Massport will consider and address the comments on noise and noise related issues. A-18

The 2015 EDR should provide an overview of the environmental regulatory framework affecting aircraft noise, the changes in aircraft noise, and the updates in noise modeling. The chapter should report on 2015 conditions and compare those conditions to those of 2014 for the following:

- Fleet Mix, including Stage II, Recertified Stage III, newly manufactured Stage III, and qualifying Stage IV aircraft;
- Nighttime operations;
- Runway utilization (report on aircraft and airline adherence with runway utilization goals);
- Preferential runway advisory system (PRAS) tracking; and
- Flight tracks.

A-19

In 2015, the FAA introduced a new combined noise and air quality modeling tool, the Aviation Environmental Design Tool (AEDT), which must be used for all airport projects. The AEDT is a software system that dynamically models aircraft performance in space and time to produce fuel burn, emissions, and noise information. Noise contours for 2015 will be developed using AEDT and compared to the most recent version of the Integrated Noise Model (INM) which has been in place for all previous EDRs and ESPRs. Logan Airport-specific model

adjustments made to account for over-water sound propagation and the propagation of sound to areas of higher terrain may be reported as an add-on to AEDT, if accepted by the FAA. This 2015 EDR should report on the following:

- Changes in annual noise contours and noise-impacted population;
- Measured versus modeled noise values, including reasons for differences and any improvements attributable to the models deployed;
- Cumulative Noise Index (CNI);
- Times-Above for 65, 75, and 85 dBA threshold values/Dwell and Persistence of noise levels; and
- Flight track monitoring noise reports.

A-20

The 2015 EDR should also report on noise abatement efforts, results from Boston Logan Airport Noise Study (BLANS) study, and provide an update on the noise and operations monitoring system. A-21

<u>Air Quality/Emissions Reduction</u>

The 2014 EDR provides an overview of airport-related air quality issues in 2014 and also efforts to reduce emissions. The air quality modeling reported in 2014 EDR is based on aircraft operations, fleet mix characteristics, and airfield taxiing times combined with ground support equipment (GSE) usage, motor vehicle traffic volumes, and stationary source utilization rates. Total air quality emissions from all sources associated with Logan Airport in 2014 are significantly less than they were a decade ago. The EDR attributes this downward trend to Massport's longstanding objective to accommodate the demands of increasing passenger and cargo activity levels with fewer aircraft operations generating fewer emissions.

In 2014, calculated emissions of volatile organic compounds (VOC), oxides of nitrogen (NOx), and particulate matter (PM) went up slightly. This was primarily attributable to changes in the modeling software, MOVES2014. Overall, modeled air quality emissions were similar in 2014 to 2013 conditions and followed recent trends. The changes in 2014 modeled air quality emissions, as compared to 2013, are primarily due to technical changes in the model itself. Inputs to the model include aircraft operations, fleet mix characteristics, and airfield taxi times combined with ground service equipment (GSE) usage, motor vehicle traffic volumes, and stationary source utilization rates. Model versions used in the 2014 analyses differed in terms of emission factors, most notably otor vehicle emissions. The modeled air quality conditions in 2014 for Logan Airport were for carbon monoxide (CO), NOx, VOCs, and PM.

- Total VOC emissions went up by 3 percent (1,177 kilograms per day [kg/day]) in 2014 compared to 2013. The increase is primarily due to the corresponding increase in aircraft landing and take-offs (LTOs) and an increase in jet fuel and gasoline usage when compared to 2013. For comparison, total VOC emissions were 1,777 kg/day in 2000.
- Total NOx emissions went up by less than 1 percent in 2014 (4,040 kg/day) compared to 2013. This slight increase in 2014 is mostly attributable to the larger number of air carrier operations during this time period. For comparison, total NOX emissions were 5,707 kg/day in 2000.

EEA# 3247 EDR Certificate November 13, 2015

- Total CO emissions went down by 5 percent in 2014 (6,987 kg/day) compared to 2013. This decrease is mostly attributable to the decrease in GSE factors and motor vehicle emission factors in accordance with MOVES2014. For comparison, total CO emissions were 13,111 kg/day in 2000.
- Total $PM_{10}/PM_{2.5}$ emissions went up by approximately 3 percent in 2014 (95 kg/day) compared to 2013. This small increase is primarily attributable to the higher emission factors of MOVES2014.
- Total greenhouse gas (GHG) emissions went down by approximately 1 percent in 2014 compared to 2013. This decrease was primarily due to a decrease in vehicle miles traveled (VMT).
- Massport's Air Quality Initiative (AQI) has tracked NOx emissions since the benchmark year of 1999. Total NO_x emissions in 2014 were 722 tons per year (tpy) lower than the 1999 benchmark which represents an overall decrease of 31 percent in NOx emissions since 1999 when the program was initiated. For comparison, NO_x emissions in 2013 were 730 tpy lower than the benchmark.

Massport has also committed to include an inventory of GHG emissions from Logan Airport in the 2015 EDR. GHG emissions should be quantified for aircraft, GSE, motor vehicles and stationary sources using appropriate emission factors and methodologies. The 2015 EDR should include an overview of the environmental regulatory framework affecting aircraft emissions, changes in aircraft emissions, and the changes in air quality modeling. The 2015 EDR should provide discussion on progress on the national and international levels to decrease air emissions. It should also include analysis methodologies and assumptions and report on conditions using the FAA's new AEDT model, described above. It will compare results to the most recent version of the Emissions Dispersion Modeling System (EDMS) that has been used in recent EDR/ESPR filings. It should include emissions inventories for CO, NO_x, VOCs, and PM emissions by airline. The 2015 EDR should also report on Massport's and Tenant's Alternative Fuel Vehicle Programs and Logan Airport air quality studies undertaken by Massport or others, as available. A-22

The results of the 2015 GHG emissions inventory should be compared to the 2014 results. This chapter should also include an update on Massport's efforts to encourage the use of single engine taxiing under safe conditions. A-23

<u>Water Quality/Environmental Compliance</u>

The 2014 EDR describes Massport's ongoing environmental management activities including National Pollutant Discharge Elimination System (NPDES) compliance, stormwater, fuel spills, activities under the Massachusetts Contingency Plan (MCP), and tank management. Massport's primary water quality goal is to prevent or minimize pollutant discharges, thus limiting adverse water quality impacts of airport activities. Massport employs several programs to promote awareness of activities that may impact surface and groundwater quality. Programs include implementing best management practices (BMPs) for pollution prevention by Massport, its tenants, and its construction contractors; training of staff and tenants; and a comprehensive stormwater pollution prevention plan. The EDR reports that Massport continues to comply with water quality and other environmental regulations.

The 2015 EDR should identify any planned stormwater management improvements and report on the status of:

- NPDES Permit and monitoring results for Logan Airport's outfalls and the Fire Training Facility;
- Jet fuel usage and spills;
- MCP activities;
- Tank management;
- Update on the environmental management plan; and
- Fuel spill prevention.

A-24

Conclusion

I have determined that the 2014 EDR for Logan Airport has adequately complied with MEPA. The EDR provides a comprehensive overview of environmental planning, issues and data. Massport may prepare the 2015 EDR for submission in 2016 consistent with the Scope included in this Certificate.

November 13, 2015
Date

Matthew A. Beaton

Comments received:

10/30/2015	Nancy S. Timmerman
11/05/2015	Town of Milton, Office of Selectmen
11/06/2015	Stephen H. Kaiser, PhD
11/06/2015	The Boston Harbor Association
11/06/2015	Cindy L. Christiansen, PhD
11/10/2015	Bill Deignan, Cambridge Community Development Department

MAB/ACC/acc

This Page Intentionally Left Blank.

The Commonwealth of Massachusetts
Executive Office of Energy and Environmental Affairs
100 Cambridge Street, Suite 900
Boston, MA 02114

Charles D. Baker
GOVERNOR

Karyn E. Polito
LIEUTENANT GOVERNOR

Matthew A. Beaton
SECRETARY

Tel: (617) 626-1000
Fax: (617) 626-1181
http://www.mass.gov/envir

February 6, 2015

CERTIFICATE OF THE SECRETARY OF ENERGY AND ENVIRONMENTAL AFFAIRS
ON THE
2012-2013 LOGAN AIRPORT ENVIRONMENTAL DATA REPORT

PROJECT NAME	: 2012-2013 Environmental Data Report
PROJECT MUNICIPALITY	: Boston / Winthrop
PROJECT WATERSHED	: Boston Harbor
EOEA NUMBER	: 3247
PROJECT PROPONENT	: Massachusetts Port Authority
DATE NOTICED IN MONITOR	: December 10, 2014

As Secretary of Executive Office of Energy and Environmental Affairs (EEA), I hereby determine that the Environmental Data Report submitted on this project **adequately and properly complies** with the Massachusetts Environmental Policy Act (MEPA) (M.G.L. c. 30, ss. 61-62I) and with its implementing regulations (301 CMR 11.00).

Background

The environmental review process for Logan Airport has been structured to occur on two levels: airport-wide and project-specific. The Environmental Status and Planning Report (ESPR) has evolved from a largely retrospective status report on airport operations to a broader analysis that also provides a prospective assessment of long-range plans. It has thus become, consistent with the objectives of the MEPA regulations, part of the Massachusetts Port Authority's (Massport) long-range planning process. The ESPR provides a "big picture" analysis of the environmental impacts of current and anticipated levels of activities, and presents an overall strategy to minimize impacts. The ESPR is supplemented by (and ultimately incorporates) the detailed analyses and mitigation commitments associated with project-specific Environmental

Impact Reports (EIR). The ESPR is generally updated on a five-year basis; the most recent ESPR for the year 2011 was filed in April of 2013. Environmental Data Reports (EDRs) (formerly referred to as Annual Updates) are filed in the years between ESPRs. During the review of the 2011 ESPR, Massport requested that the 2012 and 2013 EDRs be combined into one document. The 2012-2013 EDR is the subject of this review. Additionally, this Certificate contains a Scope for the 2014 EDR.

The 2012-2013 EDR provides a comprehensive, cumulative analysis of the effects of all Logan Airport activities based on actual and predicted passenger activity and aircraft operation levels in 2012 and 2013, and presents environmental management plans for addressing areas of concern. The technical studies in the 2012-2013 EDR include reporting on and analysis of key indicators of airport activity levels, the regional transportation system, ground access, noise, air quality and environmental management. The 2012-2013 EDR updates and compares the data presented in the 2011 ESPR, and presents activity levels (including aircraft operations and passenger activity) and environmental conditions at Logan Airport for the calendar years 2012 and 2013. It also reports on the status of project mitigation.

Passenger levels at Logan Airport reached a new peak in 2013, exceeding the 2007 historic peak, while aircraft operations at Logan Airport remained well below the historic peak reached in 1998. The 2012-2013 EDR examines the effects of airlines operating much more efficiently with quieter fleets and flying more passengers per aircraft operation. As discussed in the 2011 ESPR, the 2012-2013 EDR anticipates further increases in activity levels and some increases in environmental impacts compared to recent years.

Scope for the 2014 EDR

General

The 2014 EDR should follow the general format of the 2012-2013 EDR status report. The 2014 EDR should include an Executive Summary and Introduction, similar to previous ESPRs and EDRs. Massport must provide background information on the environmental policies and planning that form the context of the environmental reporting, technical studies, and environmental mitigation initiatives at Logan Airport to provide context for reviewing agencies and the public. A1

The 2014 EDR should provide an update on conditions at Logan Airport for calendar year 2014, including passenger and aircraft operation activity levels. It should continue to serve as a background/context against which projects at Logan Airport can be evaluated. It should also report on the cumulative effects of Logan Airport operations and activities, compared to previous years, as appropriate. It should provide a status report on Massport's proposed planning initiatives, projects, and mitigation measures. A2

The technical studies in the 2014 EDR should include reporting on and analysis of key indicators of airport activity levels, the regional transportation system, ground access, noise, air quality, environmental management, and project mitigation tracking. The 2014 EDR must also A3

respond to those issues explicitly noted in this Certificate and the comments received on the 2012-2013 EDR.

A distribution list for the 2014 EDR (indicating those receiving documents, CDs, or Notices of Availability) should be provided in the document. This section must also include copies of all ESPR and EDR Certificates issued since the 2004 Logan ESPR (issued on August 16, 2006) to provide context for reviewers. Supporting technical appendices should be provided as necessary. A4

Response to Comments

The 2014 EDR Responses to Comments section should address all of the substantive comments from the letters listed at the end of this Certificate. The Response to Comments chapter included in the 2012-2013 EDR is well-constructed and cross-referenced. I encourage Massport to use the same format in the 2014 EDR. A5

The majority of comments received on the 2012-2013 EDR focus on noise related issues, including measurement of noise, modeling of noise contours, and noise abatement, and emission reduction issues. In addition to responding to these comments, the 2014 EDR should continue to report on the refinements to noise tracking and abatement efforts. Massport should consult directly with individual commenters where appropriate. A6

Activity Levels

The Activity Levels chapter provides a solid analysis of major activity issues and the technical appendix contains useful and detailed information. This chapter presents aviation activity statistics for Logan Airport in 2012 and 2013. Logan Airport is New England's primary domestic and international airport, operating as an origin-destination airport, rather than a connecting hub for major airlines. In 2012, Logan Airport was the 23rd busiest commercial aviation facility in North America ranked by aircraft operations, and the 20th busiest in North America ranked by number of passengers. In 2013, Logan Airport was the 21st busiest commercial aviation facility in North America ranked by aircraft operations, and remained the 20th busiest in North America ranked by number of passengers.

The total number of air passengers at Logan Airport increased by 1.1 percent to 29.2 million in 2012 and by 3.4 percent to 30.2 million in 2013, compared to 28.9 million in 2011. The 2013 passenger level represents a new record high for Logan Airport. At the same time, the total number of aircraft operations fell from approximately 368,987 in 2011 to 354,869 in 2012, a decrease of 3.8 percent. In 2013, aircraft operations increased by 1.8 percent to 361,339. Despite the increase in airport operations from 2012 to 2013, aircraft operations at Logan Airport remained well below the 487,996 operations accommodated in 2000 and the historic peak of 507,449 operations reached in 1998. Passenger aircraft operations, which accounted for 91 percent of total aircraft operations, increased by 2.4 percent in 2013 after decreasing by 3.9 percent in 2012, compared to 2011 levels.

General aviation (GA) operations which is defined as aviation activity other than commercial airline activity, accounted for seven percent of total operations in 2013. GA decreased by 0.4 percent in 2012 and decreased by 5.1 percent in 2013. The 26,682 GA operations in 2013 remain below the 35,233 GA operations that Logan Airport handled in 2000.

Airline efficiency continued to increase as the average total number of passengers per aircraft operation increased from 78.3 percent in 2011 to 82.4 percent in 2012 and 83.6 percent in 2013. The average number of passengers per aircraft operation in 2012 and 2013 represented approximately 74 percent of average aircraft seat capacity. At Logan Airport, the increasing number of passengers per flight reflects a shift away from smaller aircraft and rising load factors because airlines have reduced or restricted capacity growth after several airline mergers.

Air cargo volumes, including shipments transported in the belly compartments of passenger aircraft, decreased from 562 million pounds in 2011 to 553 million pounds in 2012, a decline of 1.4 percent compared to 2011. Over the same period, all-cargo aircraft operations fell by 16.5 percent to 5,237 million pounds. All-cargo aircraft operations fell at a faster rate than cargo volumes, because all-cargo airlines introduced larger capacity aircraft into service at Logan Airport. In 2013 air cargo volumes increased by 0.8 percent to 558 million pounds and all-cargo operations increased by 3.2 percent to 5,403 million pounds, compared to 2012.

The 2014 EDR should report on airport activity levels and aircraft operations, including:

- Aircraft operations, including fleet mix and scheduled airline services at Logan Airport;
- Passenger activity levels; A7
- Cargo and mail activities;
- Compare 2014 aircraft operations, cargo/mail operations, and passenger activity levels to 2013 activity levels; and
- Report on national aviation trends in 2014 and compare to trends at Logan Airport.

It should also report on Massport's activity level forecasts that will become the basis for the planning and impact sections that follow and for Massport's strategic planning initiatives for the future ESPR. Massport should address comments related to activity levels in the 2014 EDR. A8

Sustainability at Logan Airport

The 2012-2013 EDR describes Massport's airport wide sustainability goals. In October 2000, the Massport Board approved an Authority-wide Environmental Management Policy, which articulates Massport's commitment to protect the environment and to implement sustainable design principles. In October 2004, the Massport Sustainability Team produced the *Massachusetts Port Authority Sustainability Plan* (Sustainability Plan). The Environmental Management Policy is incorporated in the Sustainability Plan as Massport's long-term sustainability goal or vision.

The 2012-2013 EDR describes Massport's continued efforts including Massport-wide sustainability. In 2013, Massport was awarded a grant by the Federal Aviation Administration (FAA) to prepare a Sustainability Management Plan (SMP) for Logan Airport. The Logan

Airport SMP planning effort began in May 2013, and is expected to be completed in 2015. The 2012-2013 EDR indicates that the Logan Airport SMP is intended to promote and integrate sustainability, formulate a list of priority initiatives, and engage employees and tenants in the process. The 2012-2013 EDR provides an excellent overview of Massport's commitment to incorporate sustainability into all aspects of Massport's activities: Planning and Design; Construction; Operations, Maintenance and Management; and Monitoring of Environmental Performance. It also identifies specific practices to reduce impacts associated with construction and efforts to address energy intensity, percentage of renewable energy, and GHG reductions.

A specific example includes compliance with the Leading by Example Executive Order which requires state agencies to procure 15 percent of their electricity from renewable resources by 2012. The Leading by Example program has influenced Massport's own operations including its offices, heating plants, and garages resulting in Massport receiving the Leading by Example award in 2008. As part of the Leading by Example program, all new construction and major renovations over 20,000 square feet constructed by Commonwealth agencies must meet the Massachusetts LEED Plus green building standard established by the Massachusetts Sustainable Design Roundtable.

I commend Massport for its commitment and expect progress on the SMP will be incorporated into subsequent EDRs and ESPRs. The focus in the 2014 EDR should include reporting on data, identifying goals and priorities for specific Massport and tenant projects at Logan Airport that have undergone MEPA review to include energy efficiency/greenhouse gas reduction, water conservation, and waste management and recycling. A9

The 2014 EDR should report on the status of mitigation commitments for specific Massport and tenant projects at Logan Airport that have undergone MEPA review, including whether they are under construction or completed. The status of mitigation commitments made in the Section 61 Findings for the following projects should also be reported: A10

- West Garage/Central Garage (EEA #9790)
- International Gateway (EEA #9791)
- Logan Airside Improvements Planning Project (EEA #10458)
- Terminal A Replacement Project (EEA #12096)
- Southwest Service Area Redevelopment Program/Rental Car Center (EEA #14137)
- Logan Runway Safety Area Improvements Project (EEA #14442)

Planning

The Airport Planning chapter in the 2012-2013 EDR provides an overview of planning, construction, and permitting activities that occurred at Logan Airport in 2012 and 2013. It also describes future planning, construction, and permitting activities and initiatives. It includes the following Airport Projects:

- Southwest Service Area (SWSA) Redevelopment Program (EEA #14137);
- Logan Airport Runway Safety Area (RSA) Improvements Project at Runway Ends 33L and 22R (EEA #14442);

- Logan Airport Runway 33L Light Pier Replacement Project (EEA #14442);
- Green Bus Depot (EEA #14629);
- Martin A. Coughlin (East Boston-Chelsea) Bypass Project (EEA #14661);
- Renovations and Improvements at Terminal B;
- Terminal B Garage Improvement Project;
- North Service Area Roadway Corridor Project;
- Greenway Connector Project a pedestrian/bicycle path connecting the Bremen Street Park path to the future City of Boston pedestrian/bicycle path; and
- Hangar Upgrade Projects.

At the end of 2013, Massport initiated the Disaster and Infrastructure Resiliency Planning (DIRP) Study for Logan Airport, the Port of Boston, and Massport's waterfront assets in South and East Boston according to the 2012-2013 EDR. The DIRP Study includes a hazard analysis, modeling projected sea-level rise and storm surge, and projections of temperature and precipitation and anticipated increases in extreme weather events. The study is nearing completion. The 2014 EDR should address the DIRP Study and identify which recommendations Massport will implement in the short term to increase the resiliency of its facilities to the potential effects of climate change. A11

Massport is in the process of developing a long-term parking management plan for Logan Airport. The Long-Term Parking Management Plan will lay out a multi-part strategy for efficiently managing parking supply, pricing, and operations – both at Logan Airport and at off-Airport locations controlled by Massport – to maximize access for transit and shared-ride vehicles while minimizing both drive-and-park and pick-up/drop-off modes. The 2014 EDR should provide updates on this plan. A12

The 2014 EDR should also continue to assess planning strategies for improving Logan Airport's operations and services in a safe, secure, more efficient, and environmentally sensitive manner. As owner and operator of Logan Airport, Massport also must accommodate and guide tenant development. Therefore, the 2014 EDR should also describe the status of planning initiatives for the following areas: A13

- Roadway Corridor Project;
- Airport Parking;
- Terminal Area;
- Airside Area;
- Service and Cargo Areas; and
- Airport Buffers and Landscaping.

The 2014 EDR should provide a status report on long-range planning activities. This chapter should include the status and effectiveness of the ground access changes, including roadway and parking projects, that will consolidate and direct airport-related traffic to centralized locations and minimize airport-related traffic on external streets in adjacent neighborhoods. A14

Regional Transportation

The 2012-2013 EDR describes activity levels at New England's regional airports in 2012 and 2013 and provides an update on regional planning activities, including long-range transportation efforts.

Overall, aviation activity at New England's regional airports decreased in 2012 and 2013. In 2012, the total number of air passengers utilizing New England's commercial service airports, including Logan Airport, decreased by 1.3 percent from 44.7 million in 2011 to 44.1 million annual air passengers. The decline in the region's passenger traffic largely reflects airline service reductions at many of the regional airports in 2012. Airlines have attempted to maintain tighter capacity control, which has resulted in ongoing service cuts at various secondary and tertiary airports across the nation. While passenger traffic at Logan Airport increased slightly in 2012, reduced passenger levels at regional airports resulted in an overall decline for the region. In 2013, however, overall passenger traffic at New England commercial airports recovered somewhat, increasing 2.8 percent from 44.1 million to 45.4 million passengers. Passenger traffic at New England airports in 2013 was the highest since the economic downturn in 2008. In 2013, total passenger traffic at the regional airports increased 1.6 percent from the previous year, while passenger traffic at Logan Airport increased by 3.4 percent.

The 2014 EDR should describe Logan Airport's role in the region's intermodal transportation system by reporting on the following:

Regional Airports

- 2014 regional airport operations, passenger activity levels, and schedule data within an historical context;
- Status of plans and new improvements as provided by the regional airport authorities;
- Ground access improvements; and
- Role of the Worcester Regional Airport and Hanscom Field in the regional aviation system and Massport's efforts to promote these airports.

A15

Regional Transportation System

- Massport's role in managing the regional transportation facilities within the restructured Massachusetts Department of Transportation (MassDOT);
- Massport's cooperation with other transportation agencies to promote efficient regional highway and transit operations; and
- Report on metropolitan and regional rail initiatives and ridership.

Ground Access to and from Logan Airport

The 2012-2013 EDR reports on transit ridership, roadways, traffic volumes, and parking for both 2012 and 2013. Specifically, the average daily vehicular traffic on Airport roadways decreased by 0.2 percent from 99,449 in 2011 to 99,281 in 2012, and then increased by 3.5 percent to 102,771 between 2012 and 2013. The 2012-2013 EDR also updates information on the Logan Parking Freeze limit which is set at 21,088, of which 18,415 are dedicated to commercial

parking spaces and 2,673 are dedicated to employee parking spaces. The EDR indicates that Massport continued to be in full compliance with the Parking Freeze throughout 2012 and 2013.

The 2012-2013 EDR includes key findings for ground access activity to and from the Airport which include:

- Massachusetts Bay Transportation Authority (MBTA) Silver Line bus boardings at the Airport continued to grow, based on ridership estimates.
- In 2012, Blue Line transit boardings at Airport Station increased about seven percent over 2011 levels. In 2013, MBTA Blue Line ridership increased six percent over 2012 levels.
- In 2012, ridership levels on all types of water transportation to the Airport remained flat in comparison to the previous year. Ridership on the MBTA ferry continues to decline, while private water taxi use has grown slightly since 2007. In 2013, ridership on private water taxis increased by three percent.
- In 2012, air passengers using Logan Express bus service increased 10 percent compared to 2011 levels; employee use of Logan Express increased by 16 percent and non-employee passengers increased nearly five percent. In 2013, non-employee passenger ridership increased nearly eight percent over 2012 levels, and employee passenger activity increased almost two percent.
- In September 2013, Massport solicited an operator for a Back Bay express shuttle bus service, which commenced in April 2014. The Back Bay Logan Express, provides improved service to those transit riders who are affected by the two-year Government Center MBTA Station closure and increases high occupancy vehicle (HOV) use from the inner Boston area.

The 2014 EDR should report on the following conditions and provide a discussion of analysis in 2014 and compare them to 2013:

- Detailed description of compliance with Logan Airport Parking Freeze;
- High occupancy vehicle (HOV) ridership (including Blue Line, Silver Line, Water Transportation, and Logan Express);
- Massport's cooperation with other transportation agencies to increase transit ridership to and from Logan Airport via the Blue Line and Silver Line;
- Logan Airport Employee Transportation Management Association (Logan TMA) services;
- Logan Airport gateway volumes;
- On-airport traffic volumes;
- On-airport vehicle miles traveled (VMT);
- Parking demand and management (including rates and duration statistics);
- Status of long-range ground access management strategy planning; and
- Results of the 2013 Logan Airport Passenger Survey.
- Massport's target HOV mode share along with incentives; and,
- Non-Airport through-traffic;

A16

Noise Abatement

The 2012-2013 EDR updates the status of the noise environment at Logan Airport in 2012 and 2013, and describes Massport's efforts to reduce noise levels. Many of the issues raised in the noise analysis are ongoing and require continuous monitoring. The 2014 EDR should address the noise issues raised by numerous commenters on the 2012-2013 EDR

Compared to 2011, the 2012 Day-Night Average Sound Level (DNL) 65-decibel (dB) contours were slightly larger in East Boston, Revere, South Boston, and Winthrop and smaller over Boston Harbor towards Long Island and south towards Columbia Point. The 2012 contours remained substantially smaller than the 2000 contours. There are several factors that influenced the contour changes, including: Runway 15R-33L, the nighttime noise abatement runway, was temporarily closed from June 16, 2012 through October 2, 2012 to allow for the second and final period of construction of the enhanced Runway 33L RSA. There were also partial construction closures of the runway before and after this period. Typically, this runway is used during these periods for head-to-head operations (arrivals to Runway 33L and departures from Runway 15R) at night, which keeps air traffic over Boston Harbor, and away from the community. The 2012 RSA construction closure was extended for longer period than in 2011, which also extended the use of other runways for nighttime operations during 2012. During this period, night operations primarily used Runway 22R and Runway 9 for departures and Runway 4R, 27, and 22L for arrivals.

Compared to 2012, the 2013 DNL 65 dB contours were slightly larger in East Boston and slightly smaller in Revere, South Boston, and Winthrop. The 2013 contours remained substantially smaller than the 2000 contours. There are several factors that influenced the contour changes, including:

- Runway use in 2013 was reflective of a typical year (return to pre-construction conditions), with an increased use (compared to 2012) of Runway 15R-33L and Runway 27;
- The availability of all runway configurations in 2013, resulted in lower levels of arrivals to Runways 22L, 27, and 4R;
- Due to the runway closure, the overall number of people exposed to DNL values greater than 65 dB increased to 4,736 people in 2012 from 3,947 people in 2011 (an increase of 789 people); and
- In 2013 with runway use back to pre-construction patterns, the overall number of people exposed to DNL values greater than 65 dB decreased to 4,307 people in 2013 from 4,736 people in 2012 (a decrease of 429 people).

The number of people residing within the DNL 70 dB contour increased from 130 people in 2011 to 200 people in 2012 and returned to 130 people in 2013. These levels are still well below the number of people exposed in the year 2000 when 17,745 people were exposed to DNL noise levels greater than 65 dB and 1,551 people were exposed to DNL levels greater than 70 dB. All of the residences exposed to levels greater than DNL 65 dB in 2012 and 2013 have been eligible to participate in Massport's residential sound insulation program (RSIP). Participation in the program is voluntary and Massport has provided sound insulation to all of homeowners who

have chosen to participate. An additional 76 residential units received sound insulation treatment in 2013 bringing the program total to 11,409 residential units. Massport will continue to seek funding for this program.

Massport is participating in a FAA aircraft noise study as part of the Airside Improvement Project mitigation. The primary focus of the Boston Logan Airport Noise Study (BLANS) is to determine viable ways to reduce noise from aircraft operations to and from Logan Airport without diminishing airport safety and efficiency. The Runway Navigation (RNAV) departure portions of Phase 1 of the project, first implemented in 2010, continued to be utilized in 2012 and 2013. The 2012-2013 EDR detailed the Flight Track Monitoring reports in Appendix of Noise Abatement.

The information in the Noise Abatement chapter is very informative and I encourage Massport to continue with detailed analysis in the 2014 EDR. I strongly advise Massport to consider and address the comments on noise and noise related issues.

The 2014 EDR should provide an overview of the environmental regulatory framework affecting aircraft noise, the changes in aircraft noise, and the updates in noise modeling. The chapter should report on 2014 conditions and compare those conditions to those of 2013 for the following:

- Fleet Mix, including Stage II, Recertified (Hushkitted) Stage III, newly manufactured Stage III, and qualifying Stage IV aircraft; A17
- Nighttime operations;
- Runway utilization (report on aircraft and airline adherence with runway utilization goals);
- Preferential runway advisory system (PRAS) tracking; and
- Flight tracks.

The 2014 EDR should also report on 2014 conditions and compare those to 2013 conditions for the following noise indicators:

- Using the FAA's most current version of the Integrated Noise Model (INM), and RealContoursTM and RealProfilesTM, produce an accurate set of Day-Night Sound Level (DNL) noise contours.
- Update on FAA's combined air quality and noise modeling tool (Aviation Environmental Design Tool - AEDT) A18
- Noise-impacted population;
- Measured versus modeled noise values, including reasons for differences and any improvements attributable to the use of RealContoursTM and RealProfilesTM;
- Cumulative Noise Index (CNI);
- Times-Above for 65, 75, and 85 dBA threshold values/Dwell and Persistence of noise levels;
- Installation and benefits of the new noise monitoring system; and
- Flight track monitoring noise quarterly reports.

The 2014 EDR should also report on noise abatement efforts, results from Boston Logan Airport Noise Study (BLANS) study, and provide a status update on the new noise and operations monitoring system. A19

Air Quality/Emissions Reduction

The 2012-2013 EDR provides an overview of airport-related air quality issues in 2012 and 2013 and also efforts to reduce emissions. The air quality modeling reported in 2012-2013 EDR is based on aircraft operations, fleet mix characteristics, and airfield taxiing times combined with ground support equipment (GSE) usage, motor vehicle traffic volumes, and stationary source utilization rates. Motor vehicle emissions for the 2012 analysis were obtained from the United States Environmental Protection Agency's (EPA's) MOBILE model (MOBILE6.2.03) combined with MassDEP-recommended motor vehicle fleet mix data, operating conditions, and other Massachusetts-specific input parameters. The most up-to-date EPA mobile model, Motor Vehicle Emission Simulator (MOVES), was used to develop 2013 motor vehicle emission factors. For comparative purposes, both MOBILE and MOVES were used to generate the 2013 motor vehicle emission factors.

The following is a summary of modeled air quality conditions for Logan Airport in the 2012 to 2013 time-period:

- Total volatile organic compound (VOC) emissions in 2012 were 1,080 kilograms per day (kg/day), or approximately three percent lower than 2011 levels. By comparison, total VOC emissions in 2013 were 1,138 kg/day, or 5 percent higher than 2012 levels. For comparison, total VOC emissions were 1,777 kg/day in 2000.
- Total emissions of oxides of nitrogen (NO_x) in 2012 were 4,099 kg/day, or less than one percent higher than 2011 levels. However, total emissions of NO_x in 2013 were 4,020 kg/day, or two percent lower than 2012 levels. For comparison, total NO_x emissions were 5,707 kg/day in 2000.
- Total emissions of carbon monoxide (CO) in 2012 were 6,739 kg/day, or three percent lower than 2011 levels. However, total emissions of CO in 2013 were 7,340 kg/day, or nine percent higher than 2012 levels. For comparison, total CO emissions were 13,111 kg/day in 2000.
- Total emissions of particulate matter $(PM)_{10}/PM_{2.5}$ increased in 2012 by approximately seven percent to 72 kg/day compared to 2011 levels. This particular increase is unique and is mostly attributable to a change the MOBILE6.2.03 model. Total modeled emissions of $PM_{10}/PM_{2.5}$ again increased in 2013 by approximately 28 percent to 92 kg/day compared to 2012 levels. This increase is primarily attributable to the updated computer modeling (i.e., Emissions and Dispersion Modeling System [EDMS] and MassDEP-preferred model –MOVES) used to calculate aircraft and motor vehicle emissions.
- With respect to Massport's Air Quality Initiative (AQI) 1999 benchmark, total NO_x emissions in 2012 were 698 tons per year (tpy) lower than the benchmark and in 2013 emissions were 730 tpy lower than the benchmark. This represents an overall decrease of 31 percent in NO_x emissions since 1999. For comparison, total NO_x emissions in 2000 were 51 tpy lower than the benchmark or a decrease of 2 percent since 1999.

The year 2013 marks the seventh consecutive year in which Massport has voluntarily prepared a greenhouse gas (GHG) emissions inventory for the EDR/ESPR. The 2012 and 2013 GHG emission inventory was again prepared following methodological guidance by the Transportation Research Board's (TRB) Airport Cooperative Research Program (ACRP). Total Logan Airport GHG emissions in 2012 were approximately three percent lower than 2011 levels primarily due to lower fuel consumption by stationary sources. Total Logan Airport GHG emissions in 2013 were approximately six percent higher than 2012 levels primarily due to the increase in usage of passenger ground access vehicles on off-airport roadways. In 2012, Massport-related emissions represented 10 percent of total GHG emissions at the Airport; tenant-based emissions represented approximately 69 percent; electrical consumption represented 14 percent; and passenger vehicle emissions represented six percent. Similarly, in 2013, Massport-related emissions represented 13 percent of total GHG emissions at the Airport, tenant-based emissions represented approximately 66 percent, electrical consumption represented 10 percent, and passenger vehicle emissions represented 10 percent.

The 2014 EDR should include an overview of the environmental regulatory framework affecting aircraft emissions, changes in aircraft emissions, and the changes in air quality modeling. The 2014 EDR should provide discussion on progress on the national and international levels to decrease air emissions. It should also include analysis methodologies and assumptions and report on 2014 conditions using the most recent versions of the EDMS and MOVES models. The 2014 EDR should include an emissions inventory for CO, NO_x, VOCs, and PM. It should include NO_2 monitoring and identify NO_x emissions by airline. A20

The 2014 EDR should also report on the following AQI for 2014: A21

- AQI Emissions Monitoring and Tracking;
- Massport's and Tenant's Alternative Fuel Vehicle Programs; and
- The status of Logan Airport air quality studies undertaken by Massport or others, as available.

Massport has also committed to include an inventory of GHG emissions from Logan Airport in 2014. GHG emissions should be quantified for aircraft, GSE, motor vehicles and stationary sources using emission factors and methodologies outlined in the MEPA Greenhouse Gas Emissions Policy and Protocol. The results of the 2014 GHG emissions inventory should be compared to the 2013 results. This chapter should also include an update on Massport's efforts to encourage the use of single engine taxiing under safe conditions. A22

Water Quality/Environmental Compliance

The 2012-2013 EDR describes Massport's ongoing environmental management activities including National Pollutant Discharge Elimination System (NPDES) compliance, stormwater, fuel spills, activities under the Massachusetts Contingency Plan (MCP), and tank management.

The 2014 EDR should report on the 2014 status of:

- NPDES Permit and monitoring results for Logan Airport's outfalls and the Fire Training Facility;
- Jet fuel usage and spills;
- MCP activities;
- Tank management;
- Update on the environmental management plan; and
- Fuel spill prevention.

It should also identify any planned stormwater management improvements.

A23

Conclusion

I have determined that the 2012-2013 EDR for Logan Airport has adequately compiled with MEPA. Massport may prepare a 2014 EDR for submission in 2015 consistent with the scope included in this Certificate.

February 6, 2015
Date

Matthew A. Beaton

Comments received:

01/14/2015	Frank J. Ciano
01/26/2015	Cindy L. Christiansen
01/26/2015	City of Somerville, Mayor Joseph Curtatone
01/27/2015	The Boston Harbor Association
01/27/2015	Nancy S. Timmerman
02/02/2015	Massachusetts Department of Public Health

MAB/ACC/acc

This Page Intentionally Left Blank.

The Commonwealth of Massachusetts
Executive Office of Energy and Environmental Affairs
100 Cambridge Street, Suite 900
Boston, MA 02114

Deval L. Patrick
GOVERNOR

Timothy P. Murray
LIEUTENANT GOVERNOR

Richard K. Sullivan Jr.
SECRETARY

Tel: (617) 626-1000
Fax: (617) 626-1181
http://www.mass.gov/envir

June 14, 2013

CERTIFICATE OF THE SECRETARY OF ENVIRONMENTAL AFFAIRS
ON THE
2011 LOGAN AIRPORT ENVIRONMENTAL STATUS AND PLANNING REPORT

PROJECT NAME	: 2011 Environmental Status and Planning Report
PROJECT MUNICIPALITY	: Boston and Winthrop
PROJECT WATERSHED	: Boston Harbor
EOEA NUMBER	: 3247
PROJECT PROPONENT	: Massachusetts Port Authority (Massport)
DATE NOTICED IN MONITOR	: April 24, 2013

As Secretary of Environmental Affairs, I hereby determine that the Environmental Status and Planning Report submitted on this project **adequately and properly complies** with the Massachusetts Environmental Policy Act (G. L. c. 30, ss. 61-62H) and with its implementing regulations (301 CMR 11.00). A-1

The environmental review process for Logan Airport has been structured to occur on two levels: airport-wide and project-specific. The Environmental Status and Planning Report (ESPR) has evolved from a largely retrospective status report on airport operations to a broader analysis that also provides a prospective assessment of long-range plans. It has thus become, consistent with the objectives of the MEPA regulations, part of Massport's long range planning. The ESPR provides a "big picture" analysis of environmental impacts associated with current and anticipated levels of activities, and presents an overall mitigation strategy aimed at avoiding increases in such impacts. The ESPR analysis is supplemented by (and ultimately incorporates) the detailed analyses and mitigation commitments of project-specific Environmental Impact Reports (EIR). The ESPR is generally updated on a five year basis, with much less detailed Environmental Data Reports (EDR) (formerly Annual Updates) filed in the years between ESPRs. The 2011 ESPR is the subject of this review. In addition, Massport has requested to combine the 2012-2013 EDRs into one document. I have considered and granted this request. This Certificate also contains a Scope for the 2012-2013 EDR. A-2

A-3 In general, the ESPR has responded to the scope. In particular, the 2011 ESPR contains a wealth of useful data on activity levels and impacts, and lays out a forecast for trends in the future years. The technical studies in the 2011 ESPR include reporting on and analysis of key indicators of airport activity levels, the regional transportation system, ground access, noise, air quality, environmental management, and project mitigation tracking. The 2011 ESPR updates and compares the data presented in the 2010 EDR, and presents activity levels (including aircraft operations and passenger activity) and environmental conditions at Logan Airport for calendar year 2011. In addition to the annual report on 2011 conditions, two other primary functions of this 2011 ESPR are to provide a discussion of future activity levels at Logan Airport through the year 2030 based on an updated forecast, and to predict the associated potential environmental conditions at the Airport in 2030. The 2011 ESPR also presents historical data on the environmental conditions at Logan Airport dating back to 1990 in instances where historical information is available. Historical data are included in the technical appendices. Overall the 2011 ESPR provides a comprehensive, cumulative analysis of the effects of all Logan Airport activities based on actual and predicted passenger activity and aircraft operation levels in 2011 and 2030 and presents environmental management plans for addressing areas of environmental concern.

The majority of comments received on the 2011 ESPR focused on noise issues, including measurement of noise, modeling of noise contours, and noise abatement. In addition to responding to these comments, the 2012-2013 EDR should also report on the progress and other refinements for tracking noise and abatement efforts, as further described in the Scope below.

Background

In 1979, the Secretary of the Executive Office of Environmental Affairs issued a Certificate requiring Massport to define, evaluate, and disclose, every three years, the impact of long-term growth at the airport through a Generic Environmental Impact Report (GEIR). The Certificate also required the submission of interim Annual Updates to provide data on conditions for the years between the GEIRs. The GEIR provided projections of environmental conditions where the cumulative effects of individual projects could be understood. The Secretary's Certificate on the *1997 Annual Update* proposed a revised environmental review process for Logan Airport. As a result, Massport evaluates the cumulative impacts associated with airport activities through preparation of an ESPR every five years and provides data updates annually through the EDRs.

Review of the 2011 ESPR and Scope for the 2012-2013 EDR

Framework for the 2011 ESPR

Massport has adopted a new, long-term forecast for the long-range planning horizon,

2030. Previous forecasts for the 1999 ESPR and the 2004 ESPR forecasts anticipated that Logan Airport would be handling 37.5 million annual passengers in 2015 and 42.8 million passengers in 2020, respectively. The 2011 ESPR revisits previous forecasts and revises them based on current and predicted conditions, and to consider a more distant time horizon.

For this 2011 ESPR, Massport updated the Logan Airport long-range forecast with 2015, 2020, and 2030 as the forecast years. Three scenarios were also developed (Low, Moderate, and High). Massport views the Moderate forecast scenario as the most likely forecast of future activity levels at Logan Airport. Massport's forecast under the Moderate scenario predicts that there will be 39.8 million passengers using Logan Airport in 2030. The updated forecast takes into account slower-than-anticipated passenger growth (compared to previous forecasts), the increasing efficiency of aircraft (higher passenger load factors), and fleet mix trends, including a growing prevalence of larger capacity jet aircraft. This 2011 ESPR examines both airside and landside activities, including planned Massport projects, and projects being carried out by others that affect the Airport, such as the FAA's Boston Logan Airport Noise Study (BLANS). Future year projections incorporate available information about projects that have undergone or are currently under MEPA review.

Cumulative analysis of airport activities are based on actual and projected passenger activity levels, aircraft operations, and the facilities and services needed to serve them. Analysis conditions for current and future years are used to assess environmental conditions and to develop, evaluate, and adjust environmental management actions.

General

The 2012-2013 EDR should follow the general format of the 2010 EDR status report on Massport's planning initiatives, projects, and mitigation measures. The 2012-2013 EDR should include an Executive Summary and Introduction, similar to previous ESPRs and EDRs. A-4

Massport must provide necessary background information to allow reviewing agencies and the public to understand the environmental policies and planning which form the context of the environmental reporting, technical studies, and environmental mitigation initiatives at Logan Airport. A-5

Specifically, the 2012-2013 EDR should provide an update on conditions at Logan Airport for calendar year 2012 and 2013. The EDR should continue to serve as a background/context against which projects at Logan Airport can be evaluated. It should also report on the cumulative effects of Logan Airport operations and activities, compared to previous years, as appropriate. A-6

The 2012-2013 EDR should report on 2012 and 2013 passenger and aircraft operation activity levels. This will be followed by a status report on Massport's proposed planning initiatives and projects and mitigation. In this way, Massport should provide the necessary background information to allow the reviewer to understand the environmental policies and A-7

A-7 cont. planning which form the context of the environmental reporting, technical studies, and environmental mitigation initiatives at Logan Airport.

A-8 The technical studies in the 2012-2013 EDR should include reporting on and analysis of key indicators of airport activity levels, the regional transportation system, ground access, noise, air quality, environmental management, and project mitigation tracking. The 2012-2013 EDR must also respond to those issues explicitly noted in this Certificate and the comments received on the 2011 ESPR.

A-9 A distribution list for the 2012-2013 EDR (indicating those receiving documents, CDs, or Notices of Availability) should be provided in the document. This section must also include copies of all ESPR and EDR Certificates issued since the 2004 Logan Environmental Status and Planning Report (issued on August 16, 2006) to provide context for reviewers. Supporting technical appendices should be provided as necessary.

Responses to Comments

A-10 The 2012-2013 EDR must include responses to comments that address all of the substantive comments from the letters listed at the end of this Certificate. The responses to comments included in the 2011 ESPR is well-constructed and cross-referenced. Massport may follow the same format in addressing comments in the 2012-2013 EDR.

A-11 The majority of comments received on the 2011 ESPR focus on noise related issues, including measurement of noise, modeling of noise contours, and noise abatement, and emission reduction issues. In addition to responding to these comments, the 2012-2013 EDR should continue to report on the refinements to noise tracking and abatement efforts. Massport should consult directly with individual commenters where appropriate.

Activity Levels

The Activity Levels chapter provides a solid analysis of major activity issues and the technical appendix contains useful and detailed information. This section in the 2011 ESPR specifically presents aviation activity statistics for Logan Airport in 2011 and compares activity levels to the prior year. The specific activity measures discussed include air passengers, aircraft operations, fleet mix, and cargo/mail volumes. This chapters also provides Massport's long-range 2030 aviation forecast for Logan Airport.

A-12 The 2012-2013 EDR must report on airport activity levels, including information on aircraft operations, including fleet mix, passenger activity levels, and cargo and mail operations. A primary purpose of this section of the 2012-2013 EDR will be to report on airport activity levels for 2012 and 2013, including:

- Aircraft operations, including fleet mix and scheduled airline services at Logan Airport;

- Passenger activity levels; A-12 cont.
- Cargo and mail activities;
- Compare 2012 and 2013 aircraft operations, cargo/mail operations, and passenger activity levels to 2011 activity levels; and
- Report on national aviation trends in 2012/2013 and compare to trends at Logan Airport.

It should also report on Massport's activity level forecasts that will become the basis for the planning and impact sections that follow and for Massport's strategic planning initiatives over the next few years. A-13 In addition to reporting the analysis of major activity issues, I advise Massport to consider and attempt to address all comments related to activity levels in the 2010 EDR. A-14

Planning

The Airport Planning chapter in the 2011 ESPR provides an overview of planning, construction, and permitting activities that occurred at Logan Airport in 2011. It also describes known future planning, construction, and permitting activities and initiatives.

The 2012-2013 EDR should continue to assess planning strategies for improving Logan Airport's operations and services in a safe, secure, more efficient, and environmentally sensitive manner. As owner and operator of Logan Airport, Massport also must accommodate and guide tenant development. Therefore, the 2012-2013 EDR should describe the status of planning initiatives for the following areas: A-15

- Roadway Corridor Project;
- Airport Parking;
- Terminal Area;
- Airside Area;
- Service and Cargo Areas; and
- Airport Buffers and Landscaping.

The 2012-2013 EDR should continue to assess the status of long-range planning activities. The chapter should report on the status of public works projects implemented by other agencies within the boundaries of Logan Airport. A-16 The chapter will also report on the status and effectiveness of the ground access related changes including roadway and parking projects, which consolidate and direct airport-related traffic to centralized locations and minimize airport-related traffic on external streets in adjacent neighborhoods. A-17

Regional Transportation

In general, the 2011 ESPR has met the requirements with respect to regional transportation issues. It describes activity levels at New England's regional airports in 2011 and updates recent regional planning activities. A-18

Overall, aviation activity at New England's regional airports increased in 2011, because the regional airports experienced a modest recovery after the 2008/2009 Economic Recession. Highlights for the regional airports and the status of long-range regional transportation planning efforts in the region which are relevant to Massport's three airports as well as the regional transportation network are provided in the 2011 ESPR.

A-19 The 2012-2013 EDR should describe Logan Airport's role in the region's intermodal transportation system by reporting on the following:

Regional Airports

- 2012 and 2013 regional airport operations, passenger activity levels, and schedule data within an historical context;
- Status of plans and new improvements as provided by the regional airport authorities;
- Ground access improvements to the regional airports; and
- The role that Worcester Regional Airport and Hanscom Field play in the regional aviation system and Massport's efforts to promote these airports.

Regional Transportation System

- Massport's role in managing the regional transportation facilities within the restructured Massachusetts Department of Transportation (MassDOT);
- Massport's cooperation with other transportation agencies to promote efficient regional highway and transit operations; and
- Report on metropolitan and regional rail initiatives and ridership.

Ground Transportation

The 2011 ESPR reported on transit ridership, roadways, traffic volumes and parking for 2011. It also provides forecasts for traffic volumes, parking, and VMT for the year 2030.

A-20 The 2012-2013 EDR should report on 2012 and 2013 conditions and provide a comparison of 2012 and 2013 findings to those of 2011 for the following:

- Detailed description of compliance with Logan Airport Parking Freeze;
- High occupancy vehicle (HOV) ridership (including Blue Line, Silver Line, Scheduled, Unscheduled, Water Transportation, and Logan Express);
- Logan Airport Employee Transportation Management Association (Logan TMA) services;
- Logan Airport gateway volumes;
- On-airport traffic volumes;
- On-airport vehicle miles traveled (VMT);
- Parking demand and management (including rates and duration statistics);
- Status of long-range ground access management strategy planning; and

- Results of the 2013 Logan Airport Passenger Survey.

The 2012-2013 EDR should also present a discussion of the following topics:

- Definition of HOV;
- Massport's target HOV mode share along with incentives;
- Non-Airport through-traffic;
- Massport's cooperation with other transportation agencies to increase transit ridership to and from Logan Airport via the Blue Line and Silver Line;
- Report on Logan Express usage and efforts to increase capacity and usage;
- Progress on enhancing water transportation to and from Logan Airport;
- Progress on rental car consolidation;
- Report on results of ground access study; and
- Strategies for enhancing services and increasing employee membership in the Logan Airport TMA.

A-20 cont.

Noise

The 2011 ESPR updates the status of the noise environment at Logan Airport in 2011, and describes Massport's efforts to reduce noise levels. It also provides noise contour population counts for 2030. The technical appendix contains useful and detailed information, while the main document provides a solid analysis of major noise issues. Many of the issues raised in the noise analysis are ongoing and require continuous monitoring. The future 2012-2013 EDR represents an appropriate forum to serve this updating function and to address the noise issues raised by numerous commenters on the 2011 ESPR. A-21

In 2011 the following changes occurred in the Airport noise environment:

- Compared to 2010, the 2011 DNL decibel (dB) contours were smaller in East Boston and over Boston Harbor toward Hull. The DNL 65 dB contour was slightly larger in Revere, South Boston, and in most of Winthrop for 2011.
- The overall number of people exposed to DNL values greater than 65 dB increased to 3,947 people in 2011 from 3,830 people in 2010 (an increase of 117 people). The number of people residing within the DNL 70 dB contour remained at 130 people. These levels are well below the numbers of people exposed in the year 2000 when 17,745 people were exposed to DNL noise levels greater than 65 dB and 1,551 people were exposed to DNL levels greater than 70 dB.
- In 2011, Massport provided sound insulation to 114 homes, 84 percent of which were in Chelsea. The focus of the program in Chelsea was to fulfill federal and state mitigation commitments related to the opening of Runway 14-32. Since the inception of Massport's residential sound insulation program (RSIP), 11,333 homes have received sound insulation treatment in East Boston, South Boston, Winthrop, Revere, and Chelsea.

Based on the 2030 forecast of aircraft operations and expected aircraft fleet mix, the following conditions are expected in 2030:

- There is forecast to be a larger number of operations and a higher percent of jet fleet activity than in 2011. The higher level of operations is not a capacity challenge as the Airport has operated in the past with over 1,300 operations per day.
- The 2030 fleet mix consists of 81 percent commercial jets whereas the 2011 fleet mix consists of 78 percent commercial jets. The 2000 fleet mix had a lower proportion of commercial jets at 62 percent of the fleet.
- Total operations are expected to increase by 29 percent or 290 operations per day from 2011 to 2030, from 1,011 operations per day in 2011 to 1,301 operations per day in 2030. Compared to 2000, which is the last year that Logan Airport had over 1,300 daily operations, 2030 is forecasted to have 54 fewer daily operations (1,355 in 2000 and 1,301 in 2030). Daytime commercial operations are projected to increase by 254 operations per day from 819 in 2011 to 1,073 in 2030, however this is still fewer than the 1,142 daytime operations in 2000. Nighttime commercial operations are projected to increase from 114 in 2011 to 154 in 2030. This is an increase compared to 2000 when 126 daily operations occurred at night.
- The 2030 operations forecast produced a larger set of DNL noise contours with the number of people exposed to noise levels greater than DNL 65 dB increasing from 3,947 in 2011 to 12,211 people in 2030. This is still significantly fewer than the number of people exposed in 2000 (17,745 people). The number of people within the DNL 70 dB is also projected to increase from 130 in 2011 to 352 people in 2030 but still remaining well below the 1,551 people within the DNL 70 dB in 2000. All of the residences within the forecasted 2030 DNL 65 dB contour are in areas where Massport has implemented its sound insulation program.

A-22 The information in this chapter is very informative and I encourage Massport to continue with detailed analysis in the 2012-2013 EDR. I strongly advise Massport to consider and address the comments on noise and noise related issues.

A-23 The 2012-2013 EDR should provide an overview of the environmental regulatory framework affecting aircraft noise, the changes in aircraft noise, and the updates in noise modeling. The chapter should report on 2012 and 2013 conditions and compare those conditions to those of 2011 for the following:

- Fleet Mix, including Stage II, Recertified (Hushkitted) Stage III, newly manufactured Stage III, and qualifying Stage IV aircraft;
- Nighttime operations;
- Runway utilization (report on aircraft and airline adherence with runway utilization goals);
- Preferential runway advisory system (PRAS) tracking; and
- Flight tracks.

The 2012-2013 EDR should also report on 2012 and 2013 conditions and compare those to 2011 conditions for the following noise indicators:

- Using the Federal Aviation Administration's (FAA) most current version of the Integrated Noise Model (INM), and RealContoursTM and RealProfilesTM, produce an accurate set of Day-Night Sound Level (DNL) noise contours. Adjustments made to account for over-water sound propagation and the propagation of sound to areas of higher terrain will be reported;
- Noise-impacted population;
- Measured versus modeled noise values, including reasons for differences and any improvements attributable to the use of RealContoursTM and RealProfilesTM;
- Cumulative Noise Index (CNI);
- Times-Above for 65, 75, and 85 dBA threshold values/Dwell and Persistence of noise levels;
- Installation and benefits of the new noise monitoring system; and
- Flight track monitoring noise quarterly reports.

A-23 cont.

The 2012-2013 EDR should also report on noise abatement efforts, results from Boston Logan Airport Noise Study (BLANS) study, and provide a status update on the new noise and operations monitoring system. A-24

Air Quality

The 2011 ESPR provides an overview of airport-related air quality issues in 2011 and efforts to reduce emissions. It also predicts emission levels for 2030. Overall total volatile organic compounds (VOC) emissions were 1,109 kilograms per day (kg/day), or 9 percent higher than 2010 levels, but still follow a long-range (i.e., a period of over 20 years) downward trend decreasing by almost 76 percent since 1990. This one-year increase is primarily due to the increase in landing and takeoff operations (LTOs) when compared to 2010 (176,322 LTOs in 2010 and 184,494 LTOs in 2011). Total emissions of oxides of nitrogen (NOX) were 4,077 kg/day, or 2 percent higher than 2010 levels. In 2011, total NOx emissions at Logan Airport were approximately 29 percent lower than 2000 levels. Also, total NOx emissions in 2011 were 707 tons per year (tpy) lower than Massport's 1999 Air Quality Initiative (AQI) benchmark. This represents an overall decrease of 30 percent in NOx emissions since 1999. Total emissions of carbon monoxide (CO) were 6,919 kg/day, or 3 percent lower than 2010 levels and 53 percent lower than 2000 levels; following the same long-range downward trend as VOCs and NOx. Total emissions of particulate matter (PM10/PM2.5) associated with Logan Airport increased in 2011 by approximately 5 percent to 67 kg/day compared to 2010 levels, but still following a long-range downward trend decreasing by 19 percent since 2005 (2005 is the first year that PM10/PM2.5 emissions were reported). This one-year increase is mostly attributable to the corresponding increase in stationary source use, particularly snow melters in conjunction with the unusually heavy snowfall in early 2011.

Since 1999, there has been a continuing trend of decreasing nitrogen dioxide (NO2) concentrations at both the Massport and Massachusetts Department of Environmental Protection (MassDEP) monitoring sites located in the vicinity of Logan Airport. In addition, the annual NO2 concentrations at all monitoring locations in 2011 continued to be well within the National Ambient Air Quality Standards (NAAQS) for NO2. The NO2 monitoring program was discontinued in 2012. Massport's Air Quality Monitoring Study is now complete, having collected data on a variety of ambient air pollutants over a two-year period as a means of assessing any air quality changes attributable to the operation of the Centerfield Taxiway which was completed in 2009. The findings from this Study will be submitted to MassDEP in 2013, and reported in the next Logan Airport EDR.

A-25

2011 marks the fifth consecutive year in which Massport has voluntarily prepared a greenhouse gas (GHG) emissions inventory for the EDR/ESPR. The 2011 GHG emission inventory was prepared following methodological guidance by the Transportation Research Board's (TRB) Airport Cooperative Research Program (ACRP). The 2011 inventory assigns GHG emissions based on ownership or control (whether it is controlled by Massport, the airlines or other airport tenants, or the general public). Total Logan Airport GHG emissions in 2011 were 5 percent higher than 2010 levels primarily due to the increase in aircraft operations and passenger vehicles accessing the Airport. Massport-related emissions represent only 12 percent of total GHG emissions at the Airport, tenant-based emissions represent approximately 68 percent, electrical consumption represents 14 percent; and passenger vehicle emissions represent 6 percent. This inventory is one of the three GHG emissions inventories Massport prepares annually; however, the other two only comprise stationary sources of GHGs and are filed with MassDEP and the U.S. Environmental Protection Agency (EPA) respectively.

A-26

The 2012-2013 EDR should include an overview of the environmental regulatory framework affecting aircraft emissions, changes in aircraft emissions, and the changes in air quality modeling. The chapter should provide discussion on progress on the national and international levels to decrease air emissions to provide context for this chapter. The chapter will also discuss analysis methodologies and assumptions and report on 2012 and 2013 conditions using the most recent versions of the Emissions Dispersion Modeling System (EDMS) and MOBILE motor vehicle emissions. The 2012-2013 EDR should include:

A-27

- Emissions inventory for carbon monoxide (CO)
- Emissions inventory for oxides of nitrogen (NOx)
- Emissions inventory for volatile organic compounds (VOCs)
- Emissions inventory for particulate matter (PM)
- Nitrogen dioxide (NO2) monitoring
- NOx emissions by airline

A-28

The 2012-2013 EDR should also report on the following air quality initiatives (AQI) for 2012 and 2013:

- Air Quality Initiative Tracking;

- Massport's and Tenant's Alternative Fuel Vehicle Programs; and
- The status of Logan Airport air quality studies undertaken by Massport or others, as available. A-28 cont.

Massport has also committed to include an inventory of greenhouse gas (GHG) emissions from Logan Airport in 2012 and 2013. GHG emissions should be quantified for aircraft, ground service equipment (GSE), motor vehicles and stationary sources using emission factors and methodologies outlined in the MEPA Greenhouse Gas Emissions Policy and Protocol. The results of the 2012 and 2013 GHG emissions inventory should be compared to the 2011 results. This chapter should also include an update on Massport's efforts to encourage the use of single engine taxiing under safe conditions. A-29 A-30

Water Quality/Environmental Compliance

The 2011 ESPR describes Massport's ongoing environmental management activities including National Pollutant Discharge Elimination System (NPDES) compliance, stormwater, fuel spills, activities under the Massachusetts Contingency Plan (MCP), and tank management.

The 2012-2013 EDR should report on the 2012/2013 status of:
- National Pollutant Discharge Elimination System (NPDES) Permit and monitoring results for Logan Airport's outfalls and the Fire Training Facility;
- Jet fuel usage and spills;
- Massachusetts Contingency Plan (MCP) Activities;
- Tank management;
- Update on the environmental management plan; and A-31
- Fuel spill prevention.

The chapter should also present a discussion of the following topics:
- Future stormwater management improvements (if any); and
- Future MCP and tank management activities.

Sustainability at Logan Airport

This chapter describes Massport's airport-wide sustainability goals. In October 2000, the Massport Board approved an Authority-wide Environmental Management Policy that articulates Massport's commitment to protect the environment and to implement sustainable design principles. In October 2004, the Massport Sustainability Team produced the *Massachusetts Port Authority Sustainability Plan* (Sustainability Plan). The Environmental Management Policy is incorporated in the Sustainability Plan as Massport's long-term sustainability goal or vision. It also identifies the actions necessary to achieve the goals, the staff members responsible for each sustainability goal, and the timeline for achieving the goals.

A-32 The 2012-2013 EDR should report on the status of mitigation commitments for specific Massport and tenant projects at Logan Airport that have undergone MEPA review and other commitments and have commenced construction. The status of mitigation commitments made in the Section 61 Findings for the following projects should also be reported:
- West Garage/Central Garage
- International Gateway
- Runway Ends 22R and 33L Runway Safety Area Improvements
- Replacement Terminal A
- Logan Airside Improvements Planning
- Southwest Service Area Redevelopment Program

A-33 This chapter should also update the status of Massport's mitigation commitments and also will identify projects for which mitigation is complete.

Distribution of the 2012-2013 EDR

A-34 Massport should explore opportunities to advance the reporting of information through Massport's website. Massport should strive to collect and analyze the information required for A-35 the 2012-2013 EDR and report this information in a timely manner. For several recent projects, including the 2011 ESPR, Massport has published bi-lingual meeting and project notices and A-36 made the services of an interpreter available upon request. Massport should consider continuing these services for the 2012-2013 EDR submittal.

Conclusion

I have determined that the 2011 ESPR for Logan Airport has adequately complied with MEPA and that Massport must submit a 2012-2013 EDR that responds to the issues raised in A-37 comments received. The 2012-2013 EDR must include a copy of this Certificate and a copy of each comment letter received on the 2011 ESPR. In particular, Massport should provide a thorough examination of issues raised regarding individual noise monitoring locations, noise measurement and modeling, noise abatement, and air quality issues.

June 14, 2013
Date

Richard K. Sullivan Jr.

Comments Received:

06/06/2013 Philip Johenning
06/07/2013 Nancy Timmerman
06/07/2013 Stephen Kaiser, PhD
06/07/2013 Darryl Pomicter
06/07/2013 Town of Milton
06/14/2013 The Boston Harbor Association

RKS/ACC/acc

This Page Intentionally Left Blank.

Copy of the Secretary of the Executive Office of Energy and Environmental Affairs Certificate issued for the Terminal E Modernization Project Environmental Notification Form

This Page Intentionally Left Blank.

The Commonwealth of Massachusetts

Executive Office of Energy and Environmental Affairs
100 Cambridge Street, Suite 900
Boston, MA 02114

Charles D. Baker
GOVERNOR

Karyn E. Polito
LIEUTENANT GOVERNOR

Matthew A. Beaton
SECRETARY

Tel: (617) 626-1000
Fax: (617) 626-1081
http://www.mass.gov/eea

December 16, 2015

CERTIFICATE OF THE SECRETARY OF ENERGY AND ENVIRONMENTAL AFFAIRS
ON THE
ENVIRONMENTAL NOTIFICATION FORM

PROJECT NAME	: Terminal E Modernization
PROJECT MUNICIPALITY	: East Boston
PROJECT WATERSHED	: Boston Harbor
EEA NUMBER	: 15434
PROJECT PROPONENT	: Massachusetts Port Authority
DATE NOTICED IN MONITOR	: November 9, 2015

Pursuant to the Massachusetts Environmental Policy Act (M.G. L. c. 30, ss. 61-62I) and Section 11.06 of the MEPA regulations (301 CMR 11.00), I have carefully reviewed the Environmental Notification Form (ENF), comments submitted on it, and have carefully considered whether an EIR is warranted. The project is undergoing MEPA review and requires an ENF pursuant to 301 CMR 11.03(6)(b)(6) because it will be undertaken by a State Agency and consists of the expansion of an existing terminal at Logan Airport by greater than 100,000 sf. The project does not exceed a Mandatory EIR threshold. Mandatory EIR thresholds are established to identify a category of projects, or aspects thereof, for which it is presumed that the environmental impacts warrant additional analysis in an EIR.

Comments identify concerns with the project and its impacts and identify broader concerns associated with airport operations and growth. These include comments from Senator Petruccelli, Representative Madaro, and Councilor LaMattina; Representative Garett J. Bradley; the City of Boston Environment Department; the Town of Hull; the Milton Board of Selectmen; representatives of the Massport Citizens Advisory Committee (CAC); and many residents. I have weighed these concerns against the presumption that the project is not subject to a Mandatory EIR and that Massport will prepare an Environmental Assessment (EA) for review pursuant to the National Environmental Policy Act (NEPA), which will include additional opportunities for public comment.

I have determined that additional information regarding the necessary details of design and development of the Terminal E expansion is warranted to properly assess potential impacts. The Scope for the EIR is narrowly tailored to the project and its specific impacts. It is intended to

augment the federal review process, not duplicate it. The EIR is not intended to address broad concerns associated with airport operations and growth. The venue for addressing cumulative environmental impacts is through the Environmental Status and Planning Reports (ESPR) and Environmental Data Reports (EDR).

Through these reports, Logan Airport is subject to comprehensive and regular MEPA review, including opportunities for public comment. This regular updating and reporting on planning and cumulative impacts is unique among State Agencies. It reflects the challenge and complexity of managing and modernizing Logan Airport within a dense, urban area. It recognizes that the proximity of communities to the Airport warrants an enhanced level of public engagement and a concerted, long-term effort to minimize and mitigate impacts.

I expect that Massport can prepare a Draft EIR that will adequately address the Scope such that I may determine, pursuant to 301 CMR 11.08, that no substantive issues remain to be addressed and allow the DEIR to be reviewed as a Final EIR (FEIR) or as a Response to Comments on the DEIR.

Project Description

The project proposes modernizing Boston-Logan International Airport's John A. Volpe International Terminal (Terminal E) with a 500,000 to 700,000-square foot (sf) addition that corrects facility deficiencies and accommodates current and anticipated passenger volumes. The project includes three gates which previously underwent MEPA review (International Gateway Project, EEA #9791) but were not constructed, and two to four additional aircraft gates, passenger holdrooms, concourse, concessions, and passenger processing areas. The project includes Customs and Border Patrol (CBP) and Federal Inspection Services (FIS) facilities to replace and expand FIS facilities that were originally reviewed under MEPA (Terminal B, Pier A Improvements/Satellite FIS Facility, EEA #12235) but also not constructed. The project also includes a direct pedestrian connection between Terminal E and the Massachusetts Bay Transportation Authority's (MBTA) Blue Line Airport Station.

Terminal E was constructed in 1974 with 12 gates and served 1.4 million annual passengers. In 2014, it served approximately five million passengers. The ENF indicates that the current level of passenger activity routinely causes severe congestion in the terminal and negatively impacts customer service and operations. During peak late afternoon and early evening periods, passengers experience severe congestion and delays at the ticket counters and security screening areas, and there is insufficient seating, concessions, and other support services. The ENF indicates that aircraft must use remote parking facilities at hardstands in the North Cargo Area and passengers are bused to the terminal during peak periods when there are insufficient gates. Massport has clearly demonstrated the need for the project and made a compelling case for the expansion.

The project is proposed in two phases. The first phase could include up to five new gates; part of the concourse extension, including the majority of the additional terminal processing area; roadway and curb improvements; and direct pedestrian connections to the MBTA Blue Line Airport Station. The second phase would primarily consist of the remainder of the concourse area, additional gates, holdrooms, boarding bridges; support spaces such as concessions, mechanical spaces, airline and airport operations spaces; and passenger processing areas. Both

phases include airside modifications to accommodate aircraft maneuvering, taxiing, parking, and docking operational requirements.

The project will displace ground service equipment (GSE), other airside activities, existing surface parking, the cell phone lot, and the gas station which will be relocated within existing airport boundaries.

Environmental Status and Planning Report (ESPR)

The MEPA environmental review process for Logan Airport occurs on two levels: airport-wide and project-specific. The ESPR and EDR provide a "big picture" analysis of the environmental impacts of current and anticipated levels of airport-wide activities (including aircraft operations and passenger activity), and presents comprehensive strategies to avoid, minimize and mitigate impacts. The ESPR is generally updated on a five-year basis; the most recent ESPR for the year 2011 was filed in April 2013. Environmental Data Reports (EDRs) evaluate environmental conditions for the reporting year as compared to the previous year and are filed in the years between ESPRs. The most recent EDR for the year 2014 was filed in October 2015. The ESPR is supplemented by (and ultimately incorporates) the EDRs and the detailed analyses and mitigation commitments that emerge from project-specific reviews. This process provides a comprehensive and continuous review of airport programs, projects, environmental impacts and associated data.

The MEPA regulations (Section 11.06(2)) indicate that during the course of an ENF review I may review any relevant information from any other source to determine whether to require an EIR, and, if so, what to require in the Scope. To provide context for this project-specific review and because many issues raised by commenters relate to airport-wide operations and impacts, this Certificate refers to documents from the Environmental Status and Planning Report (ESPR) process (EEA#3247/5146). Massport indicates that the Terminal E project is consistent with the analysis presented in the Environmental Status and Planning Report (ESPR) and has incorporated that document by reference into the ENF as the framework for analyzing cumulative impacts of, and mitigation for, Logan Airport projects, and considers the regional transportation context.

The 2011 ESPR reported on key indicators of airport activity levels, the regional transportation system, ground access, noise, air quality, environmental management, and project mitigation tracking. In addition to the annual report on 2011 conditions, the ESPR evaluated the cumulative impacts of passenger growth and associated ground and aircraft operations looking forward to 2030. The ESPR also presented environmental management plans for addressing areas of environmental concern.

The 2011 ESPR identifies a future phase of the International Gateway Project – Terminal E, which includes three new gates, and assumes it is constructed by 2030. The 2012/2013 EDR also identifies this project and indicates it will be constructed beyond 2022. The 2014 EDR identifies the Terminal E Modernization Project as a stand-alone project. It indicates that it would include an additional two to four gates for a total of five to seven gates and construction could begin in 2018.

Logan Airport and Project Site

The Airport boundary encompasses approximately 2,400 acres in East Boston and Winthrop, including approximately 700 acres underwater in Boston Harbor. The Airport is surrounded on three sides by Boston Harbor and is accessible by two public transit lines and the roadway system. The airfield is comprised of six runways and approximately 15 miles of taxiway. Logan Airport has four passenger terminals, A, B, C, and E, each with its own ticketing, baggage claim, and ground transportation facilities.

Terminal E is located adjacent to the North Cargo Area, closest to the MBTA Blue Line Airport Station. Land uses in the area of the proposed project include UPS aircraft parking and loading area, the airport's Remain Over Night aircraft parking area, the North Cargo Area equipment storage area, a building occupied by United Parcel Service (UPS), the MBTA Blue Line Airport Station, airport roadways, various short-term and cell phone parking lots, and a gas station.

The project site is located within the coastal zone of Massachusetts. The entirety of the project site is comprised of previously disturbed impervious area. It is not located in Priority or Estimated Habitat as mapped by the Division of Fisheries and Wildlife's (DFW) Natural Heritage and Endangered Species Program (NHESP). The project site does not contain wetland resource areas regulated pursuant to the Wetland Protect Act and its implementing regulations (310 CMR 10.00).

The ENF identified the following projects within the vicinity of Terminal E that have been reviewed under MEPA: Terminal A Replacement (EEA#9329), Terminal E Modifications (EEA#9324), Federal Inspection Services (FIS) Facility and West Concourse Project / International Gateway (EEA#9791), and Terminal B, Pier A Improvements/Satellite FIS Facility (EEA#12235).

Permitting and Jurisdiction

The project is undergoing MEPA review and requires an ENF pursuant to 301 CMR 11.03(6)(b)(6) because it will be undertaken by a State Agency and results in the expansion of an existing terminal at Logan Airport by greater than 100,000 sf.

The project requires a Sewer Permit Modification from the Boston Water and Sewer Commission (BWSC) and may require an Industrial User Permit from the Massachusetts Water Resource Authority (MWRA). The project may be subject to Massachusetts Office of Coastal Zone Management (CZM) federal consistency review.

The project requires approval by the Federal Aviation Administration (FAA) for changes to the Airport Layout Plan and, therefore, requires an Environmental Assessment (EA) under the National Environmental Policy Act (NEPA). The project also requires a National Pollutant Discharge Elimination System (NPDES) General Permit for Construction from the U.S. Environmental Protection Agency.

Because the project will be undertaken by a State Agency, MEPA jurisdiction is broad in scope and extends to all aspects of the project that may cause Damage to the Environment, as defined in the MEPA regulations.

Environmental Impacts and Mitigation

The project includes construction of approximately 500,000 to 700,000 sf of new floor area (for a maximum 1,500,000 sf total), and will increase both water consumption and wastewater generation by approximately 25,600 gallons per day (76,800 gpd total). The project will not create new impervious area and will eliminate approximately 60 parking spaces. The ENF indicates that the project will accommodate existing and forecasted passenger levels and operations and, therefore, will not increase passenger enplanements or vehicle trips.

Measures to avoid, minimize and mitigate project impacts include improving high-occupancy vehicle (HOV) access to the airport via a direct pedestrian connection to the MBTA Blue Line Airport Station and reducing air emissions, greenhouse gas (GHG) emissions, and energy consumption by providing better access to gate plug-ins and pre-conditioned air. The ENF also indicates that the building will act as a noise barrier to the adjacent neighborhood and Memorial Stadium Park.

Review of the ENF

The ENF includes a general description of proposed activities, a conceptual plan, and a limited analysis of alternatives. It does not provide a typical level of information necessary to evaluate the potential environmental impacts of the project for the purpose of MEPA review. The ENF does not address why construction projections have changed compared to the ESPR and EDR or how the increase in gates may affect the impact analysis which is based on the 2011 ESPR forecasts. The ENF provides a scope for the NEPA EA that identifies further analysis and data that will be provided to assess potential impacts and measures to avoid, minimize, and mitigate these impacts. As requested by Massport, the ENF was subject to an extended 30-day comment period to provide additional time for public review and comment. C.1

Environmental Justice

Massport provided outreach consistent with the spirit and intent of the enhanced public participation provisions of the EJ Policy. Massport requested and was granted an extension of the comment period to provide additional time to review and comment on the ENF. The meeting notice was published in The Boston Herald, The East Boston Times, and the Winthrop Transcript. It was translated into Spanish and also published in El Mundo. Spanish language translation was provided at the joint MEPA/NEPA meeting held on November 19, 2015. In addition, Massport held additional meetings and presented information regarding the Terminal E Expansion at a number of meetings from September through December. I expect that Massport will employ similar approaches to ensure public review and comment of the EIR. C.2

Massport has also provided enhanced air quality analysis and assessment of cumulative impacts in the ESPR and EDRs that address the spirit and intent of the EJ Policy. The Scope for the EA indicates that it will evaluate potential disproportionate noise and air quality impacts for existing and future build years 2022 and 2030; demonstrate how it will avoid, minimize, and/or mitigate these impacts to the greatest feasible extent; and, ensure that its proposed actions will not unduly burden low income or minority areas. C.3

I have received numerous comment letters regarding environmental justice and concerns that the burden of cumulative noise, air pollution, and traffic impacts associated with growth and increased operations will be borne by neighboring communities, independent of this specific project. The Executive Office of Energy and Environmental Affairs (EEA) Environmental Justice Policy (EJ Policy) was designed to improve protection of low income and communities of color from environmental pollution as well as promote community involvement in planning and environmental decision-making to maintain and/or enhance the environmental quality of their neighborhoods.

Alternatives Analysis

The ENF identified a maximum developable footprint and indicated that all Build Alternatives will be located within previously developed land within the Airport Boundary. It did not identify a Preferred Alternative or compare relative impacts/benefits of alternatives. The ENF indicated that conceptual Build Alternatives will be developed during the NEPA permitting process based on airport industry planning standards, FAA, Customs and Border Patrol, and Transportation Security Administration (TSA) requirements that define various terminal, airside, and landside functions. The key differences among potential alternatives will relate to the internal and external layout of the building, the ability to efficiently accommodate passengers, and constructability. According to the ENF, all Build Alternatives will include phased development of three gates followed by the development of between two and four additional new gates, additional concourse with supporting facilities, a new direct pedestrian connection to the MBTA's Blue Line Airport Station, reconfiguration of adjacent roadways and short-term parking areas, and reconfiguration of some airside operations. All Build Alternatives will be located within existing paved and developed areas of the airport that are currently used for aviation or aviation-related activities. C.4

The ENF indicates that under the No-Build alternative, passenger and aircraft operations would continue to increase as projected in the 2011 ESPR, but there would be no significant changes to Terminal E interior or exterior facilities. Gate service facilities would be inadequate to efficiently handle the increase in scheduled operations and passengers and arriving aircraft would wait on the apron with engines idling until an aircraft clears a gate or park at a "hardstand" away from the Terminal at a North Cargo Area aircraft parking area and passengers will deplane using mobile stairs and be bused to the terminal. Hardstand operations, aircraft idling, and the use of on-board diesel auxiliary power units (APU) require greater use of energy, including bussing passengers to and from the terminal, and use of the aircraft engines to provide electricity to the cabin during these ground operations. The ENF indicates that the No-Build alternative would result in insufficient passenger processing capacity, long wait times at ticketing and security, and additional congestion at the curb and roadway. Based on these considerations, the No-Build alternative was eliminated.

Comments on the ENF request Massport accommodate more demand at regional airports and evaluate regional project alternatives to the proposed project. I acknowledge that long-term strategies to mitigate Logan's impacts will continue to include an emphasis on diverting travel to regional airports and to rail. Regional transportation will continue to be addressed through the ESPR and EDR, not through this project-specific review. C.5

The 2011 ESPR and 2014 EDR provide a thorough analysis of trends in regional airport activity and identify initiatives and joint efforts to improve the efficiency of the regional transportation system (including regional rail transportation initiatives). The reports identify Massport investments in Hanscom Field and Worcester Regional Airports, consistent with the findings of the 2006 New England Regional Airport System Plan (NERASP) Study. Future ESPRs and EDRs will require Massport to report on Logan's role in the regional transportation system; Massport's efforts to promote the Worcester Regional Airport and Hanscom Field; the status of plans and improvements provided by the regional airport authorities; cooperation with other transportation agencies to promote efficient regional highway and transit operations; and, report on metropolitan and regional rail initiatives and ridership. The reports demonstrate that Massport has continued to emphasize and build on opportunities to strengthen regional transportation.

Climate Change Adaptation and Resiliency Measures

Massport recently completed a Disaster and Infrastructure Resiliency Planning (DIRP) Study and generated a Floodproofing Design Guide which are intended to improve their ability to restore operational capabilities during and after major disruptions, and to adapt and enhance facilities to be more resilient to the effects of extreme weather events. The DIRP Study identified increased storm and sea-level rise as the threats with the highest probability of occurring and impacting Massport operations. The Floodproofing Design Guide also notes that Logan Airport is increasingly susceptible to flooding hazards caused by extreme storms and rising sea levels as a result of climate change.

The ENF does not include information regarding current Federal Emergency Management Agency (FEMA) floodplain mapping. MassDEP comments note that preliminary flood mapping[1] depicts the 100-year flood zone to the west of the project site, near the Airport MBTA Station. Comments from MassDEP and CZM indicate the proximity of the project to the coastal environment may make it susceptible to sea level rise and increased storm intensity and frequency-related impacts. Massport should draw on the DIRP Study and Floodproofing Design Guide to develop mitigation strategies to support the functionality and resiliency of Terminal E in the near and distant future. I encourage Massport to consult with CZM as the project design process progresses. C.6

Greenhouse Gas Emissions

Because I am requiring an EIR, the project is subject to review under the May 2010 MEPA Greenhouse Gas (GHG) Emissions Policy and Protocol ("the Policy"). The ENF indicates that Massport will quantify stationary and mobile source GHG emissions generated by the project and will identify measures to avoid, minimize, or mitigate GHG emissions to determine the applicability of state and federal requirements. I note that mobile sources will only include passenger vehicles and GSE. The ENF indicates that the energy demand of the project may require a new substation and that energy modeling will be used to quantify the GHG emissions for the terminal building. C.7 C.8 C.9

[1] Preliminary Flood Insurance Rate Map, Map Number 25025C0082J, March 16, 2016

Massport has incorporated sustainability into all aspects of its activities through a Sustainability Management Plan as described in the 2014 EDR. Recent Massport accomplishments include compliance with the Leading by Example Executive Order which requires state agencies to procure 15 percent of their electricity from renewable resources; the new Rental Car Center in the Southwest Service Area receiving Logan's first LEED Gold Certification in 2015; and expansion of the Logan Express Bus Service and ongoing support of HOV measures.

Noise

The ENF asserts that the project will not increase the number of aircraft operations when compared to the Future No-Build Alternative. The ENF also indicates that the proposed terminal building will act as a sound barrier to dampen or reflect noise because it will be positioned between the airfield and roadway. These benefits were not analyzed in the ENF. The ENF indicates that the EA will assess the potential for anticipated ground noise impacts resulting from proposed changes to the functioning of the North Cargo Area. The EA will also contain an analysis of the specific sound barrier benefits of the proposed terminal.

Impacts associated with existing operations and noise levels, and potential increases in impacts associated with this project and long-term growth, are a major concern identified in most comment letters. Letters identify a particular concern with nighttime noise and concentrations of flight tracks and increased flight frequency due to the FAA's area navigation (RNAV) procedures. As documented in the ESPR and annual EDR submittals, implementation of several of the RNAV procedures have generated increased noise complaints in some towns surrounding Logan Airport. The procedures themselves have resulted in aircraft at higher altitudes, though in patterns that are concentrated over certain communities. Since 2000, the number of daily aircraft operations and the number of people exposed to the 65 decibel (dB) Day-Night Average Sound Level (DNL) has declined by approximately 27 percent and fifty percent (respectively); reflecting a trend towards fewer overall flights with larger, more efficient, and quieter aircraft. I acknowledge that projected increases in flight operations will increase cumulative noise impacts compared to existing conditions, although they will remain below historic levels. Cumulative impacts will continue to be addressed through the ESPR and EDR, not through project specific review of the Terminal E project. C.10

Air Quality

The ENF indicates that the project will not alter runway use and will not affect the number of anticipated aircraft operations or generate any new vehicle trips. The project may alter airside ground operations in the North Cargo Area, including aircraft taxiing and parking, use of hardstands and busing, and use of supporting ground service equipment (GSE). The ENF indicates that an emissions inventory for the EPA criteria pollutants for airside ground operations (not flight operations) will be conducted for existing and future-year conditions using the recently released FAA Aviation Environmental Design Tool (AEDT). The AEDT will evaluate changes in aircraft ground operations and associated GSE and airside motor vehicle emissions will be assessed using the EPA MOVES model.

Total air quality emissions from all sources at Logan Airport in recent years are significantly less than they were a decade ago. The ENF attributes this downward trend to

Massport's longstanding objective to accommodate the demands of increasing passenger and cargo activity levels with fewer aircraft operations generating fewer emissions. The 2014 EDR demonstrated that total emissions are incrementally increasing. Massport will continue to assess the applicability of emissions reduction measures to the extent practicable and report on air quality in the ESPR and the EDR. C.11

Many comments cite the findings or request additional information on the 2004 Logan Airport Health Study performed by the Massachusetts Department of Public Health (DPH)[2]. The study was published in May 2014 and identified two respiratory outcomes for adults and children living in the high exposure area. In addition to contributions from Logan Airport, the study identified high background levels of air pollutants. The results of this study and have been reported in the annual EDR filings and include actions Massport is taking based on recommendations of the study. Cumulative air quality impacts will continue to be addressed through the ESPR and EDR, not through project specific review of the Terminal E project. C.12

The 2014 EDR indicates that Massport is working with DPH and the East Boston Health Center on implementing the DPH recommendations, including:

- Massport is providing funding to the East Boston Neighborhood Health Center to help expand the efforts of its asthma and chronic obstructive pulmonary disease (COPD) prevention and treatment program in East Boston and launch a program in Winthrop for screening children, providing asthma kits, and home visits;
- Massport entered into an agreement with the Massachusetts League of Community Health Centers for the evaluation and assessment of the Asthma and COPD Prevention and Treatment Program, and engagement of community health centers in the North End, Charlestown, Chelsea, and South Boston. The East Boston Neighborhood Health Center will conduct the same evaluations for the East Boston and Winthrop Community Program.
- Massport entered into an agreement with DPH to expand or establish the Asthma and COPD Prevention and Treatment Program in South Boston, the North End, Chelsea, and Charlestown in collaboration with the Massachusetts General Hospital and the South Boston Neighborhood Health Center, and to conduct training on the Community Health Worker assessments.

Transportation

The ENF asserts that the project will not increase passenger enplanements or vehicle trips to the airport, and therefore, the transportation analysis will be limited to the airport transportation network. The project will require relocation of existing uses in the project area to other airport locations. The ENF indicates that the EA will describe the existing transportation network at the airport, anticipated modifications to the transportation network, and anticipated transportation impacts of the project. According to the ENF, the EA will evaluate potential transportation impacts that may result from the relocated uses. The analysis will evaluate traffic impacts of the preferred alternative and a No-Build Alternative. The analysis will be conducted

[2] The study is available for download at http://www.mass.gov/eohhs/gov/departments/dph/programs/environmental-health/investigations/logan-airport-health-study.html

using the Logan Airport VISSIM model for existing and proposed conditions, with supporting traffic analyses performed using other software (Synchro and QATAR). The analysis will use the VISSIM model results from 2014 (as reported in the 2014 EDR) as the baseline year and the build conditions will be evaluated for 2022 and 2030.

The project includes construction of a direct pedestrian connection between Terminal E and the MBTA Blue Line Airport Station. The EA will include an analysis of the existing public transportation options serving the airport and evaluate the potential impacts the direct connection may have on ridership and operations. C.13

Many comments urge that I require a detailed analysis of ground transportation issues due to the cumulative impacts of landside and air operations at Logan and the identified issues with limited parking capacity. The issues of ground transportation and parking are clearly relevant to any discussion of cumulative impacts, and are an important component of any cumulative air quality analysis, which will continue to be addressed through the ESPR and EDR, not through this project specific review of the Terminal E Expansion. C.14

The ESPR and annual EDR updates include a substantial body of analysis on ground transportation issues. The 2014 EDR indicates that Massport is developing a Long-Term Parking Management Plan intended to address the parking supply, pricing and operations associated with Logan's constrained parking. Strategies to address the parking issue may have implications for design of the Terminal E Modernization project, including curbside access and/or short-term parking areas. C.15

Wastewater & Water Supply

According to the ENF, the project will generate an additional 25,600 gallons per day (gpd) of wastewater flow, for a total of 76,900 gpd. Similarly, the project will consume an additional 25,600 gpd of potable water, for a total of 76,800 gpd. MassDEP has indicated that the project will not require a Sewer Connection Permit from MassDEP. However, under the terms of the new Sewer System Extension and Connection Regulations (314 CMR 12.00), MassDEP requires that sewer authorities with permitted combined sewer overflows (CSOs), including the Boston Water and Sewer Commission (BWSC), require the removal of four gallons of infiltration and inflow (I/I) for each gallon of new wastewater flows generated by any new connection that would generate greater than 15,000 gpd. I refer Massport to comments from BWSC that provide additional guidance on this issue and identify applicable design standards for all new or relocated water mains and sewers. C.16

Comments from MWRA indicate that the project site is served by BWSC combined sewers that discharge to the MWRA's East Boston Branch Sewer. The ENF indicates that there is sufficient capacity in the existing collection system to accommodate the additional flow. I refer Massport to comments from MWRA which request the analysis also consider wet weather flow conditions. C.17

Stormwater

The ENF indicates that the project will not create new impervious area as development of the terminal will occur in an area that is already paved. The Terminal E complex will continue to drain to the North Outfall, which is equipped with end-of-pipe treatment to remove debris and floating oils and grease from stormwater prior to discharge. Comments from CZM indicate that samples from the North Outfall recently exceeded water quality standards for bacteria and recommend that Massport develop a strategy to identify and eliminate illicit sewer connections to address this issue. C.18

According to the ENF, the EA will include a drainage analysis and description of the proposed stormwater management measures and identify the size and location of stormwater management features. The EA will also demonstrate how the project will meet MassDEP Stormwater Management Standards, Logan Airport's stormwater management practices, and the requirements of the NPDES Multi-Sector General Permit under which the airport operates. I refer Massport to comments from BWSC that identify applicable design standards and plan requirements, and provide guidance on discharge of dewatering drainage. C.19

Historic and Archaeological Resources

According to the ENF, the project site does not contain any properties listed in the State or National Registers of Historic Places. The project site contains both an area and a structure that are included in the Massachusetts Historical Commission's (MHC) Inventory of Historic and Archaeological Assets of the Commonwealth (the Inventory). Specifically, the entirety of Logan Airport is identified as an Inventoried Area (MHC ID#BOS.K) and Terminal E is identified as an Inventoried Structure (MHC ID#BOS.63). The ENF contains a commitment to coordinate with MHC to identify potential impacts and avoidance, minimization, and mitigation measures.

Construction Period

The ENF does not identify specific construction period impacts or associated mitigation measures. It indicates that construction period impacts, including noise, air quality, traffic, solid and hazardous waste, and water quality will be evaluated in the EA. It will also describe project phasing and sequencing. Massport participates in MassDEP's Clean Construction Equipment Initiative and requires engine retrofits to reduce exposure to diesel exhaust fumes and particulate emissions. The ENF indicates that demolition activities will comply with MassDEP's Solid Waste and Air Quality control regulations. I refer Massport to comments from MassDEP that provide guidance on asbestos removal and the handling of asphalt, brick, and concrete. The ENF indicates Massport will recycle construction & demolition (C&D) waste. C.20

The ENF indicates that contaminated material will be managed in compliance with the Massachusetts Contingency Plan (MCP) and that a Soil Management Plan may be required to determine whether excavated soils generated through foundation construction can be used onsite or hauled off-site for reuse and/or disposal. The ENF indicates that areas near the site have been regulated under c.21E Release Tracking Number (RTN) 3-10027 (Phase V) and RTN 3-324. MassDEP comments note RTN 3-324 appears to be linked to a site in a different city. Massport should review and confirm the RTN or provide the correct RTN for the site. C.21 I refer Massport to MassDEP comments, which provide additional guidance on the excavation, removal and/or C.22

disposal of contaminated soil, pumping of contaminated groundwater, and/or working on contaminated media. C.22 Cont.

Conclusion

The ENF has provided an overview of the Terminal E Expansion, identified potential environmental impacts, and identified opportunities to avoid, minimize and mitigate impacts; however, the ENF did not provide sufficient information to demonstrate that Massport has sufficiently analyzed alternatives and measures to avoid, minimize and mitigate potential impacts of this specific proposal to the maximum extent practicable.

As noted previously, numerous comments raise concerns about the project, the management of growth at Logan Airport, the environmental and community impacts of this growth, and the mitigation of impacts. I have also received comments that suggest review of the Terminal E Modernization project has been improperly segmented under MEPA from the review of airport operations as a whole.

Massport asserts that international passenger activity is forecast to increase independent of any additional facilities. The 2011 ESPR provides accurate forecasts of passenger demand and aviation activity in 2030 and documents that demand for passenger service is primarily determined by external factors, including economic growth, cost of travel, and demographic shifts. In addition, I note that Massport has been engaged in planning to accommodate growth in international passengers and operations since the 1990's.

The issue of cumulative airport-wide impacts and segmentation is not new to the review of projects at Logan Airport. The ESPR and EDR provide a cumulative analysis of Logan Airport operations, environmental impacts, and mitigation measures. Review of individual projects proceeds within the context of this long-term planning and analysis of cumulative impacts. The record of MEPA review clearly demonstrates that Massport has and continues to identify impacts associated with individual projects within the context of long-term plans and cumulative impacts of Logan Airport. Cumulative impacts and project specific impacts will continue to be assessed on separate tracks; they will complement each other and ensure that projects are not viewed in isolation. C.23

Based on a review of the ENF, consultation with State Agencies and review of comment letters, I am requiring that Massport submit an EIR consisting of the EA and limited additional information identified in the Scope. The DEIR will consist of a project specific review of the Terminal E Modernization project within the context of airport-wide operations and impacts as a whole. The purpose of the DEIR is to:

1. Provide a detailed and comprehensive project description including conceptual design; C.24
2. Identify protect-specific impacts and the project's consistency with Logan planning and annual reporting; C.25
3. Consider how alternative building design and location, within the project site, can minimize impacts and maximize benefits; and, C.26
4. Provide draft Section 61 Findings that identify project-specific mitigation measures. C.27

Through this review, Massport will demonstrate that it has met its obligations under MEPA to avoid, minimize and mitigate impacts of the Terminal E Modernization to the maximum extent feasible.

In recognition of the comment letters that raise concerns with cumulative airport-wide impacts pertaining to traffic and parking, air quality, and noise and, consistent with the MEPA review structure for Logan Airport, I am requiring Massport to respond to comments regarding airport operations and cumulative impacts in subsequent ESPR and/or EDR documents. The next ESPR will analyze calendar year 2016 and will likely be filed in late 2017 or 2018 and the next EDR will analyze calendar year 2015 and will likely be filed in the fall of 2016. C.28

The 2015 EDR Scope includes reporting on noise, air quality, and long-term parking management. C.29 The 2016 ESPR should revise growth projections based on the changes in the Terminal E Modernization Project that occurred subsequent to the 2011 ESPR (if necessary). C.30 It should also should reflect the proposed connection to the Airport Station and identify the anticipated ridership, changes in the HOV mode share, and ground access planning considerations. C.31

SCOPE

General

The ENF included a proposed scope for the Environmental Assessment that will undergo review pursuant to the National Environmental Policy Act (NEPA). It includes a project description and permitting, alternatives, air quality, climate, coastal resources, hazardous materials, solid waste, pollution prevention, historical, architectural, archaeological and cultural resources, land use, natural resources and energy supply, noise and compatible land use, transportation, water resources, and construction impacts. In the interest of harmonizing State and federal review and in recognition of the significant and on-going planning and analysis represented by the ESPR and the EDRs, Massport may submit the EA as the Draft EIR. The EA should be supplemented by addressing the additions and modifications identified in this Scope. If Massport would prefer to tailor the EIR rather than submit the EA, the EIR should consist of the standard MEPA requirements for an EIR (Section 11.07(6)) and address the requirements of the MEPA GHG Emissions Policy and Protocol. C.32

Massport may also choose to coordinate the State and federal review. MEPA comment and review periods may be adjusted to align with NEPA deadlines. Lastly, I note that this certificate applies to the review of the project under MEPA only, and does not restrict the ability of the federal government to act on those aspects of the project subject to NEPA.

Project Description and Permitting

The EIR should identify and describe any changes to the project since the filing of the ENF and provide an update on State, local, and federal permitting. It should include a discussion of permitting requirements and document the project's consistency with regulatory standards. C.33

The EIR should include updated site plans for existing and post-development conditions at a legible scale including curbside improvements and changes to the on-airport roadways. C.34

The EIR should provide an update on consultations with the MBTA regarding the proposed connection to the MBTA Airport Station. The EIR should identify whether a Land Transfer (including easement) from MBTA will be required to construct the pedestrian connection to the MBTA Airport Station. The EIR should include a conceptual design for the proposed connection to the Airport Station and identify anticipated ridership, potential changes in the HOV mode share, and associated ground access planning considerations. C.35

Alternatives Analysis

The EIR should identify the planning metrics, facility requirements, and assumptions used to design the project and to determine the final number and location of gates. It should compare and contrast benefits and potential impacts of alternatives in narrative form and it a tabular format. C.36 The EIR should identify the peak hour used to determine gate locations and design passenger hold rooms. The EIR should identify the number of planes that are currently forced to "hard stand" during peak hours due to lack of available gates to the number of planes. It should identify the number forced to "hard stand" during peak hours under proposed alternatives. C.37 The EIR should include a discussion of the proposed project and alternatives consistency with the long-term growth forecasts contained in the ESPR and EDR. C.38

GHG Emissions and Climate Change Adaptation and Resiliency

The project is in the conceptual design state and, as such, provides meaningful opportunities for reduction GHG emissions associated with the building location, orientation and design as well as incorporation of resiliency and adaptation considerations. The EIR should describe the project's consistency with the DIRP Study and Massport's Floodproofing Design Guide to demonstrate that the project will incorporate proactive site design measures to address potential impacts related to predicted sea level rise. C.39 In addition to Massport assets, I encourage Massport to consult with the MBTA to review existing station vulnerabilities, as operations of the Blue Line and this station are important to support Massport HOV goals. C.40

The EIR should include an analysis of GHG emissions and mitigation measures in accordance with the standard requirements of the MEPA GHG Policy and Protocol. The analysis should include project-related stationary source emissions and mobile source emissions (passenger vehicles and GSE). I refer Massport to comments from DOER and MassDEP which provide additional guidance regarding mitigation measures that should be explored as part of the GHG analysis. C.41 DOER identifies combined heat and power (CHP) as a particularly promising and effective energy efficiency measure that could also support resiliency of the facility. The EIR should include a feasibility analysis of CHP and a roof-mounted solar photovoltaic (PV) system. I encourage Massport to meet with representatives from MEPA and DOER prior to preparation of the GHG analysis. C.42

Noise

The EA will include a noise analysis. The EIR should identify how the sound barrier benefits of the terminal have been maximized through its location and design. The EIR should C.43

identify whether the addition of new gates constructed to current industry standards would affect the fleet mix and, potentially, alter/increase noise and vibration on Logan Airport and within the surrounding community compared to the 2030 forecasts. C.43 Cont.

Air Quality

The EA will include an emissions inventory for the EPA criteria pollutants for airside ground operations for existing and future-year conditions to evaluate changes in aircraft ground operations and associated GSE and airside motor vehicle emissions. C.44 The EIR should quantify the impacts or benefits of providing direct access to plug-in gate operations and decreasing reliance on auxiliary power units, ground support equipment, and busing passengers around the airport. C.45 Massport should consider the potential and relative benefits of alternative building locations on the site and design between the airfield and neighborhoods as it relates to creating a potential barrier to particulate matter and other hazardous air pollutants. C.46

Construction Period

The EA IR should identify construction period impacts, including noise, air quality, traffic, solid and hazardous waste, and water quality and identify avoidance, minimization, and mitigation measures. C.47 It should also describe project phasing and sequencing. C.48

Mitigation/Draft Section 61 Findings

The EIR should include a separate chapter summarizing proposed mitigation measures. This chapter should also include draft Section 61 Findings for each area of impact associated with Massport's Preferred Alternative. The EIR should contain clear commitments to implement these mitigation measures, estimate the individual costs of each proposed measure, identify the parties responsible for implementation (either funding design and construction or performing actual construction), and a schedule for implementation. C.49 To ensure that all GHG emissions reduction measures adopted by the Proponent in the Preferred Alternative are actually constructed or performed by the Proponent, I require Proponents to provide a self-certification to the MEPA Office indicating that all of the required mitigation measures, or their equivalent, have been completed. The commitment to provide this self-certification in the manner outlined above should be incorporated into the draft Section 61 Findings included in the EIR. C.50

Responses to Comments

The EIR should contain a copy of this Certificate and a copy of each comment letter received on the ENF. Based on the large volume of comment letters received, the comment letters may be provided electronically on a CD. In order to ensure that the issues raised by commenters are addressed, the EIR should include direct responses to these comments to the extent that they are within MEPA jurisdiction. This directive is not intended, and shall not be construed, to enlarge the scope of the EIR beyond what has been expressly identified in this Certificate. The response can refer to future EDRs and/or ESPRs to address issues that are not within the DEIR Scope. C.51 In addition to items noted in the Scope, the response to comments section should address comments from MassDEP pertaining to wastewater, recycling, source reduction and water conservation efforts. C.52 The EIR should also address wet weather capacity, C.53

wastewater flows, and I/I removal requirements as outlined in MWRA and BWSC's comments. C.53 Cont. I recommend that Massport employ an indexed response to comments format, supplemented as appropriate with direct narrative response. C.54

Circulation

In accordance with Section 11.16 of the MEPA Regulations and as modified by this Certificate, Massport should circulate a hard copy of the EIR to each State and City Agency from which the Proponent will seek permits. Massport must circulate a copy of the EIR to all other parties that submitted individual written comments. Per 301 CMR 11.16(5), the Proponent may circulate copies of the EIR to these other parties in CD-ROM format or by directing commenters to a project website address. However, Massport should make available a reasonable number of hard copies to accommodate those without convenient access to a computer and distribute these upon request on a first-come, first-served basis. Massport should send correspondence accompanying the CD-ROM or website address indicating that hard copies are available upon request, noting relevant comment deadlines, and appropriate addresses for submission of comments. A CD-ROM copy of the filing should also be provided to the MEPA Office. A copy of the EIR should be made available for review at the following Libraries: Boston Public Library – Main, Connolly, Orient Heights, Charlestown, and East Boson Branches, Chelsea Public Library, Winthrop Public Library, Revere Public Library, Everett Public Library, Milton Public Library, and Hull Public Library. C.55

December 16, 2015
Date

Matthew A. Beaton

Comments received:

12/07/2015	Massachusetts Department of Environmental Protection – Northeast Regional Office (MassDEP)
12/07/2015	Massachusetts Water Resources Authority (MWRA)
12/07/2015	Madeleine Steczynski
12/07/2015	Jane O'Reilly
12/07/2015	Alexis Daniels
12/07/2015	Chris Marchi (1st letter)
12/07/2015	Jason Burrell
12/07/2015	John Casamassima
12/07/2015	Kannan Thiruvengadam
12/07/2015	Robin Maguire
12/07/2015	Susanna Starrett
12/07/2015	Theresa Turino
12/08/2015	Alfred Pucillo
12/08/2015	Duane Eric Lock
12/08/2015	Jeannie Grieci
12/08/2015	Joanne Donatelli
12/08/2015	Joanne T. Pomodoro

12/08/2015	John Antonellis
12/08/2015	Lisa Rusch
12/08/2015	Lorraine Curry
12/08/2015	Magdalena Ayed
12/08/2015	Mary Elizabeth Nofziger
12/08/2015	Nancy Lagro
12/08/2015	Normairiis Casiano
12/08/2015	Rebecca Lock
12/08/2015	Sandra Downey
12/08/2015	Danielle Dell'Olio
12/08/2015	Allyson and Michael Simons
12/08/2015	Patricia J D'Amore
12/08/2015	Jessica L. Curtis
12/08/2015	Daniel Cano on behalf of the Eagle Hill Civic Association and Jeffries Point Neighborhood Association (dated 12/02/15)
12/08/2015	Dan Bailey
12/08/2015	Matthew Neave
12/08/2015	Salvador Cartagena
12/08/2015	Alexis Pumphrey
12/08/2015	Jeff Lee
12/08/2015	Kelly Rusch
12/08/2015	Christine Passarriello
12/08/2015	Rick Lockney (with attached data)
12/08/2015	Camille MacLean
12/09/2015	Angela Mroz
12/09/2015	Pamela Loring
12/09/2015	Brian Gannon
12/09/2015	Jay Benson
12/09/2015	Peter Chipman
12/09/2015	Kathyrn Leeber
12/09/2015	Carol Taylor
12/09/2015	Rebecca Lynds
12/09/2015	Georges Arnaout
12/09/2015	Lisa Locke
12/09/2015	James Linthwaite
12/09/2015	Mary J. Ryan
12/09/2015	Steve and Chrissy Holt
12/09/2015	Paul Paquin
12/09/2015	Karis L. North
12/09/2015	David and Carissa Juengst
12/09/2015	Caroline Sulick
12/09/2015	Maria Graceffa
12/09/2015	Robyn Riddle
12/09/2015	Elda and Mark Prudden
12/09/2015	Christine Thompson
12/09/2015	Frank J. Ciano, Arlington Logan CAC and Massport CAC Representative
12/09/2015	Senator Petruccelli, Representative Madaro, Councilor LaMattina
12/09/2015	Elke O'Brien

12/09/2015	Jeff Kerr (1st letter)
12/09/2015	Christina Leshock
12/09/2015	Collin Cameron
12/09/2015	Aaron M. Toffler, on behalf of Airport Impact Relief, Incorporated (AIR, Inc.)
12/09/2015	Jason Hibbard
12/09/2015	Gisela Voss and Dan Kernan
12/09/2015	Elizabeth Kay
12/09/2015	Harvey Rowe
12/09/2015	Jill Romano, Wenham Logan CAC Representative
12/09/2015	Leanne Tirabassi
12/09/2015	Myron Kassaraba, Belmont Logan CAC and Massport CAC Representative
12/09/2015	Nancy Plotkin
12/09/2015	Larry A. Butler
12/09/2015	Rowan Curran
12/09/2015	Lois Freedman
12/09/2015	Kathleen Conlon, Milton Board of Selectmen
12/09/2015	Frank Kerr, Hull Neighbors for Quiet Skies
12/09/2015	Jim Roberts
12/09/2015	Tom Hardey
12/09/2015	Donna Goes
12/09/2015	Colleen MacDonald
12/09/2015	Brian Carney
12/09/2015	Billy Avalos
12/09/2015	John Walkey
12/09/2015	Stephan Marin
12/09/2015	Amelia Cardona
12/09/2015	Jeff Karr (2nd Letter)
12/09/2015	Priscilla Beadle
12/09/2015	H. Gerald Zeller
12/09/2015	Arnie Freedman
12/09/2015	Bonita K Koelker
12/09/2015	Mary Ellen Welch
12/09/2015	Marie & James Fraher
12/09/2015	Erica Mattison, Environmental League of MA, Massport CAC Representative
12/09/2015	Lynn Marie Ray
12/09/2015	Dennis Saide
12/09/2015	Vera Schneider
12/09/2015	Neill K. Ray
12/09/2015	Boston Harbor Association
12/09/2015	Nicole Al Rashid
12/09/2015	Ellen M. Tan, Commonwealth Land Trust
12/09/2015	Cindy L. Christiansen, Milton Logan CAC Representative
12/09/2015	Patricia Waddleton
12/09/2015	Evie Rose
12/09/2015	Carey Lam
12/09/2015	Kathy Beitler
12/09/2015	Joe Berkeley
12/09/2015	Eileen M. Boylen

12/09/2015	David Flynn
12/09/2015	Michael Passariello
12/09/2015	Richard Armenia
12/09/2015	James B. Lampke, Town of Hull, Acting Town Manager
12/09/2015	Cindy Borges-Peralta
12/09/2015	Stephen Cooper
12/09/2015	Tina St. Gelais Kelly
12/09/2015	Tara Ten Eyck
12/09/2015	Maria Ticona
12/09/2015	Ira Fleishman
12/09/2015	Andrew Schmidt
12/09/2015	Debbie Ellerin
12/10/2015	Jeeyoon Kim
12/10/2015	Boston Water and Sewer Commission (BWSC)
12/10/2015	George and Diane Nassopoulos
12/10/2015	Betsy Lewenberg
12/10/2015	Representative Garett J. Bradley
12/11/2015	Massachusetts Office of Coastal Zone Management (CZM)
12/11/2015	Chris Marchi, (2nd letter)
12/11/2015	City of Boston – Environmental Department
12/11/2015	Mary Beth Hamwey
12/11/2015	Maureen White
12/11/2015	Jesse Purvis
12/11/2015	John Tyler
12/11/2015	Renee MacLean
12/11/2015	Edward MacLean
12/11/2015	E.F. (45 Grovers Ave.)
12/11/2015	D.P. (402 Meridian St.)
12/11/2015	Daniel Cordon
12/11/2015	Tanya Hahnel
12/11/2015	B.R. (412 Summer St.)
12/11/2015	A.V. (198 Everett St.)
12/11/2015	Gillian B. Anderson
12/12/2015	Elizabeth Stoy
12/15/2015	Department of Energy Resources (DOER)

MAB/PRC/prc

This Page Intentionally Left Blank.

Copy of the Secretary of the Executive Office of Energy and Environmental Affairs Certificate issued for the Terminal E Modernization Project Draft Environmental Assessment/Environmental Impact Report

This Page Intentionally Left Blank.

The Commonwealth of Massachusetts

Executive Office of Energy and Environmental Affairs
100 Cambridge Street, Suite 900
Boston, MA 02114

Charles D. Baker
GOVERNOR

Karyn E. Polito
LIEUTENANT GOVERNOR

Matthew A. Beaton
SECRETARY

Tel: (617) 626-1000
Fax: (617) 626-1081
http://www.mass.gov/eea

September 16, 2016

CERTIFICATE OF THE SECRETARY OF ENERGY AND ENVIRONMENTAL AFFAIRS
ON THE
DRAFT ENVIRONMENTAL IMPACT REPORT

PROJECT NAME	: Terminal E Modernization
PROJECT MUNICIPALITY	: East Boston
PROJECT WATERSHED	: Boston Harbor
EEA NUMBER	: 15434
PROJECT PROPONENT	: Massachusetts Port Authority
DATE NOTICED IN MONITOR	: July 20, 2016

As Secretary of Energy and Environmental Affairs, I hereby determine that the Draft Environmental Impact Report (DEIR) submitted on this project **adequately and properly complies** with the Massachusetts Environmental Policy Act (MEPA; M.G.L. c.30, ss.61-62I) and with its implementing regulations (301 CMR 11.00). Consistent with Section 11.08 (8)(b)(2)(b) of the MEPA regulations, I am requiring the Proponent to file responses to comments on the DEIR and draft Section 61 Findings. The responses to comments and draft Section 61 Findings shall be filed, circulated, and reviewed as a Final Environmental Impact Report (FEIR). C.1

Comments on the DEIR reflect myriad concerns regarding existing airport operations and noise levels and potential increases in impacts associated with long-term growth. I have received comment letters from elected officials, including U.S. Congressman Michael E. Capuano, State Senator Joseph Boncore, State Representative Adrian Madaro, Boston City Councilor Salvatore LaMattina, and Chelsea City Councilor Roy Avellaneda. Comments were also submitted by municipalities, State and regional agencies, environmental advocacy groups, businesses and residents. The issue of cumulative airport-wide impacts, particularly noise and air quality, is not new to the review of projects at Logan Airport. As noted in past Certificates, the EIR is not intended to address broad concerns associated with airport operations and growth. The venue for addressing cumulative environmental impacts is through the Environmental Status and Planning Reports (ESPR) and Environmental Data Reports (EDR). Through these reports, Logan Airport is subject to comprehensive and regular MEPA review, including opportunities for public comment on the cumulative impacts. This regular updating and reporting on planning and cumulative impacts is unique among State Agencies. It reflects the challenge and complexity of

managing and modernizing Logan Airport within a dense, urban area. It recognizes that the proximity of communities to the Airport warrants an enhanced level of public engagement and a concerted, long-term effort to minimize and mitigate impacts.

Subsequent ESPRs and EDRs will update the cumulative impacts of passenger growth and associated ground and aircraft operations based on revised forecasts and update and revise environmental management plans to address impacts. C.2 Future submittals will continue to document potential impacts and trends and propose measures to implement the broad goal of maintaining or reducing Logan's overall environmental impacts, even as annual passenger volumes rise in the future. The next ESPR will analyze calendar year 2016 and will likely be filed in 2017 or 2018 and the next EDR will analyze calendar year 2015 and will likely be filed in the fall of 2016. C.3

Over the past year, Massport has engaged in a concerted outreach effort with elected officials, municipalities and community groups to identify and discuss potential Massport projects, including but not limited to, Terminal E. Massport created the Logan Airport Impact Advisory Group (IAG) to solicit comment and to identify and prioritize projects and programs of significance to the IAG. One project prioritized through this process is the construction of a pedestrian connection between the Massachusetts Bay Transportation Authority (MBTA) Blue Line Airport Station to Terminal E. Massport has incorporated this connection into the Terminal E project. I commend Massport for its outreach efforts which have been beneficial to informing the MEPA process. I encourage Massport to continue a productive dialogue with interested stakeholders, including through the IAG. C.4

Project Description

The project proposes modernizing Boston-Logan International Airport's John A. Volpe International Terminal (Terminal E) with a 560,000-square foot (sf) addition that corrects facility deficiencies and accommodates current and anticipated passenger volumes. The project includes three gates which previously underwent MEPA review (International Gateway Project, EEA #9791) but were not constructed, and four additional aircraft gates, passenger holdrooms, concourse, concessions, and passenger processing areas. The project includes Customs and Border Patrol (CBP) and Federal Inspection Services (FIS) facilities to replace and expand FIS facilities that were originally reviewed under MEPA (Terminal B, Pier A Improvements/Satellite FIS Facility, EEA #12235) but also not constructed. The project includes a direct pedestrian connection between Terminal E and the MBTA Blue Line Airport Station.

Terminal E was constructed in 1974 with 12 gates and served 1.4 million annual passengers. In 2014, it served approximately five million passengers. The DEIR indicates that the current level of passenger activity routinely causes severe congestion in the terminal at peak times, leading to greatly reduced customer service, and inefficient operations in the terminal and gates. According to the DEIR, gate congestion leads to airside delays and inefficiencies on the North Apron. When no gates are available, arriving aircraft and passengers are held on the apron. The DEIR indicates that aircraft must use remote parking facilities at hardstands in the North Cargo Area and passengers are bused to the terminal during peak periods when there are insufficient gates. The DEIR builds upon the information presented in the ENF regarding challenges associated with current operations at Terminal E. Massport has clearly demonstrated the need for the project and made a compelling case for the expansion.

The DEIR provided additional information to clarify and revise project phasing. The project is proposed in two phases. Phase 1 will be constructed from 2018 – 2022 and will include construction of four new gates with associated passenger holdrooms and elevators/escalators to relieve existing deficiencies and accommodate interim growth. A partial new concourse will be constructed to allow for future expansion to a seven-gate facility at full build-out. Phase 1 will not require modifications to roadway realignment. Phase 2 will be built by 2028 and will provide three additional gates and the MBTA connection. The DEIR indicates the project will be fully constructed and operational by 2030. Due to planning and budget constraints, the MBTA pedestrian connection has been shifted from Phase 1 as proposed in the ENF to Phase 2. The DEIR indicates that no other significant changes have occurred since the ENF was filed.

The project will displace ground service equipment (GSE), other airside activities, existing surface parking, the cell phone lot, and the gas station which will be relocated within existing airport boundaries. Relocation of ground facilities that conflict with the new concourse location, including the gas station, will occur in Phase 1.

Environmental Status and Planning Report (ESPR) and Environmental Data Reports (EDRs)

The MEPA environmental review process for Logan Airport occurs on two levels: airport-wide and project-specific. The ESPR and EDR provide a "big picture" analysis of the environmental impacts of current and anticipated levels of airport-wide activities (including aircraft operations and passenger activity), and presents comprehensive strategies to avoid, minimize and mitigate impacts. The ESPR is generally updated on a five-year basis; the most recent ESPR for the year 2011 was filed in April 2013 and it contained updated passenger activity levels and aircraft operations forecasts through 2030. EDRs evaluate environmental conditions for the reporting year as compared to the previous year and are filed in the years between ESPRs. The most recent EDR for the year 2014 was filed in October 2015. The EDR provided a comprehensive cumulative analysis of the effects of all Logan Airport activities based on actual passenger activity and aircraft operation levels in 2014 and presents environmental management plans for addressing environmental impacts. The ESPR is supplemented by (and ultimately incorporates) the EDRs and the detailed analyses and mitigation commitments that emerge from project-specific reviews. This process provides a comprehensive and continuous review of airport programs, projects, environmental impacts and associated data.

The 2015 EDR Scope includes, but is not limited to, reporting on noise, air quality, and long-term parking management. The 2015 EDR and 2016 ESPR should reflect the proposed connection to the Airport Station, provide updates on the planning and design of the connection, and identify the anticipated ridership, changes in the HOV mode share, and ground access planning considerations. C.5

The MEPA regulations (Section 11.06(2)) indicate that during the course of an ENF review I may review any relevant information from any other source to determine whether to require an EIR, and, if so, what to require in the Scope. To provide context for this project-specific review and because many issues raised by commenters relate to airport-wide operations and impacts, this Certificate refers to documents from the ESPR process (EEA#3247/5146).

Logan Airport and Project Site

The Airport boundary encompasses approximately 2,400 acres in East Boston and Winthrop, including approximately 700 acres underwater in Boston Harbor. The Airport is surrounded on three sides by Boston Harbor and is accessible by two public transit lines and the roadway system. The airfield is comprised of six runways and approximately 15 miles of taxiway. Logan Airport has four passenger terminals, A, B, C, and E, each with its own ticketing, baggage claim, and ground transportation facilities.

Terminal E is located adjacent to the North Cargo Area, closest to the MBTA Blue Line Airport Station. Land uses in the area of the proposed project include UPS aircraft parking and loading area, the airport's Remain Over Night aircraft parking area, the North Cargo Area equipment storage area, a building occupied by United Parcel Service (UPS), the MBTA Blue Line Airport Station, airport roadways, various short-term and cell phone parking lots, and a gas station.

The project site is located within the coastal zone of Massachusetts. The entirety of the project site is comprised of previously disturbed impervious area. It is not located in Priority or Estimated Habitat as mapped by the Division of Fisheries and Wildlife's (DFW) Natural Heritage and Endangered Species Program (NHESP). The project site does not contain wetland resource areas regulated pursuant to the Wetland Protect Act and its implementing regulations (310 CMR 10.00).

The ENF identified the following projects within the vicinity of Terminal E that have been reviewed under MEPA: Terminal A Replacement (EEA#9329), Terminal E Modifications (EEA#9324), Federal Inspection Services (FIS) Facility and West Concourse Project / International Gateway (EEA#9791), and Terminal B, Pier A Improvements/Satellite FIS Facility (EEA#12235).

Permitting and Jurisdiction

The project is undergoing MEPA review and required an ENF pursuant to 301 CMR 11.03(6)(b)(6) because it will be undertaken by a State Agency and results in the expansion of an existing terminal at Logan Airport by greater than 100,000 sf.

The project requires a Sewer Permit Modification from the Boston Water and Sewer Commission (BWSC) and may require an Industrial User Permit from the Massachusetts Water Resource Authority (MWRA). The project may be subject to Massachusetts Office of Coastal Zone Management (CZM) federal consistency review.

The project requires approval by the Federal Aviation Administration (FAA) for changes to the Airport Layout Plan and, therefore, requires an Environmental Assessment (EA) under the National Environmental Policy Act (NEPA). The project also requires a National Pollutant Discharge Elimination System (NPDES) General Permit for Construction from the U.S. Environmental Protection Agency.

Because the project will be undertaken by a State Agency, MEPA jurisdiction is broad in scope and extends to all aspects of the project that may cause Damage to the Environment, as defined in the MEPA regulations.

Environmental Impacts and Mitigation

As described in the ENF, the project includes construction of approximately 500,000 to 700,000 sf of new floor area (for a maximum 1,500,000 sf total), and will increase both water consumption and wastewater generation by approximately 25,600 gallons per day (76,800 gpd total). The project will not create new impervious area and will eliminate approximately 60 parking spaces. The DEIR indicates that the project will accommodate existing and forecasted passenger levels and operations and, therefore, will not increase passenger enplanements or vehicle trips.

Measures to avoid, minimize and mitigate project impacts include reducing air emissions, greenhouse gas (GHG) emissions, and energy consumption compared to existing conditions by improving access to gate plug-ins, pre-conditioned air, and reducing busing operations. In addition, the building is designed to act as a noise barrier to the adjacent residential areas and Memorial Stadium Park.

Review of the DEIR

The DEIR has been filed to provide additional information regarding the necessary details of design and development of the Terminal E expansion to support assessment of potential impacts and has been coordinated with the federal NEPA process. In accordance with my Certificate on the ENF, the Environmental Assessment (EA) as required under NEPA formed the basis of the DEIR.[1] This Certificate applies to the review of the project under MEPA only, and does not restrict the ability of the federal government to act on those aspects of the project subject to NEPA. The DEIR included FAA's draft Finding of No Significant Impact (FONSI). The DEIR described the proposed project, identified existing conditions, described potential environmental impacts and mitigation measures, and provided an expanded discussion of alternatives. It included an update on state, local, and federal permitting and provided a discussion of permitting requirements and the project's consistency with regulatory standards. At Massport's request, the comment period was extended by three weeks to September 9, 2016. C.6

The DEIR identified ongoing projects that are currently under construction and are assumed to be completed prior to commencement of construction for the Terminal E Project. It also identified a potential parking garage, which is predicated on the approval of a draft regulatory change by MassDEP to amend the Logan Airport Parking Freeze Regulation (310 CMR 7.30). The DEIR indicates that the potential parking garage will be subject to MEPA review pursuant to 301 CMR (6)(a)(7) because it will be constructed by a State Agency and will include construction of 1,000 or more new parking spaces. This project is conceptual in nature and the DEIR did not provide a schedule or timeline for its design or construction or for initiating MEPA review. I encourage Massport to consult with the MEPA Office prior to preparing an ENF for this project. C.7

[1] The Federal Aviation Administration (FAA) is reviewing the project as an Environmental Assessment (EA) under the National Environmental Policy Act (NEPA).

Environmental Justice Policy

I have received numerous comment letters regarding environmental justice and concerns that the burden of cumulative noise, air pollution, and traffic impacts associated with growth and increased operations will be borne by neighboring communities, independent of this specific project. The Executive Office of Energy and Environmental Affairs (EEA) Environmental Justice Policy (EJ Policy) was designed to improve protection of low income and communities of color from environmental pollution as well as promote community involvement in planning and environmental decision-making to maintain and/or enhance the environmental quality of their neighborhoods. Massport provided outreach consistent with the spirit and intent of the enhanced public participation provisions of the EJ Policy. Massport requested and was granted an extension of the comment period to provide additional time to review and comment on the DEIR. The meeting notice was published in English and Spanish in the Boston Herald and the East Boston Times. Spanish language translation was also provided at a Public Information Meeting held the evening of August 10, 2016 at the Mario Umana Middle School Academy Auditorium in East Boston. I received many comment letters requesting Massport provide a Spanish language version of the Executive Summary provided with the DEIR filing. Massport has indicated it will provide a Spanish translation of the DEIR Executive Summary. I encourage Massport to continue providing translated Executive Summaries with all future MEPA filings. C.8

Alternatives Analysis

The DEIR included an expanded alternatives analysis that identified the planning metrics, facility requirements, and assumptions used to design the project and to determine the final number of gates based on the passenger projections for year 2030. The DEIR provided a gating analysis for forecast passenger activity and aircraft operations levels to determine the number of gates required to accommodate the volumes of passengers and aircraft that will be arriving and departing at Terminal E during the average weekday peak-hours. As described in the DEIR, Massport has limited control over the scheduling of transatlantic flights, which are subject to lengthy flight times and time zone changes that cause arrival and departure peaks to occur within a relatively short time period. The DEIR indicates that peak hour for international departures will be between 9:00 pm to 10:00 pm and the peak hour for international arrivals will be between 6:00 pm and 7:00 pm. According to the DEIR, approximately 1,954 passengers are projected to depart in 2030 during the peak hour (9:00 pm to 10:00 pm) and 1,885 passengers are projected to arrive during the peak hour (6:00 pm to 7:00 pm). Based on this, the gating analysis indicates that Logan Airport will require an additional seven gates for a total of 19 gates to efficiently support international operations.

The DEIR identified the number of planes that are forced to "hard stand" during peak hours due to lack of available gates under existing, future No-Build, and future Build-Conditions. As described in the DEIR, in the summer of 2015, aircraft scheduling demanded 13 gates, one more than the existing twelve gates. Throughout 2015, only 10 of the existing 12 Terminal E gates were available for use as two were decommissioned to allow for construction of the Terminal E Renovation and Enhancements Project. From April to September 2015, facility constraints at Terminal E resulted in 293 gate-delays, which affected approximately 44,000 passengers and 49 ramp busing operations to remote hardstands which affected over 8,200 passengers. As described in the DEIR, aircraft waiting for gates account for 55-percent of total delays at Terminal E, while busing operations to remote hardstands account for 11-percent of

total delays. According to the DEIR, in the proposed (2030) Build-Condition, only two operations will require use of a "hard stand" and busing, whereas under the No-Build, 17 flights (arrival and departure) per day will require busing operations. The DEIR also included a summary of key aircraft gate and passenger terminal area facility program requirements for the proposed project to address current deficiencies and meet the needs for future anticipated aircraft and passenger handling.

The DEIR evaluated the following alternate configurations of the new terminal area and the North Apron:

- Alternative A: Separate Core Terminal – New linear concourse and terminal core, with new separate curb frontage.
- Alternative B: Concourse Extension – Extension from existing concourse extending westward from the Gate 12 area at the west end of Terminal E.
- Alternative C: Satellite Concourse – New portion of the terminal positioned as a separate two-sided concourse structure with underground passageway connecting the new gates to the existing terminal space.
- Alternative D: Extended Core Terminal *(Preferred Alternative)* – New extension of the existing concourse, terminal core, and terminal frontages.

Each alternative included seven new gates consistent with the need identified in the gating analysis. The key differences among the terminal configuration alternatives relate to efficiency of interior operations, frontage on the adjacent roadway, disruption to the existing operations during construction, and cost. With the exception of the ability to buffer ground noise from ground operations, there is little difference in environmental impacts among the alternatives. Alternative D was selected as it provides the greatest passenger processing efficiency, interior space, and noise buffering benefits compared to the other alternatives. Massport also evaluated three alternative roadway configurations based on the preferred terminal configuration. The three roadway alternatives (Bi-Level S-Curves, Single S-Curve, and Northern Loop Ramps) all extend the roadway frontage to facilitate drop-off and pick-up along the new building area, and realign the roadway ramps servicing Terminal E. The DEIR indicates that the roadway configurations have similar environmental impacts since the limit of work is currently fully developed and that all build options will replicate the existing traffic flow patterns. The Preferred Alternative (Single S-Curve) was selected as it provides the best alignment for traffic operations while minimizing the overall footprint.

Comments on the DEIR continue to request that Massport accommodate more demand at regional airports in lieu of or in conjunction with the proposed project. I acknowledge that long-term strategies to mitigate Logan's impacts will continue to include an emphasis on diverting travel to regional airports and to rail. As indicated in the Certificate on the ENF, regional transportation will continue to be addressed through the ESPR and EDR, not through this project specific review. C.9

GHG Emissions

Because I required an EIR, the project is subject to review under the May 2010 MEPA Greenhouse Gas (GHG) Emissions Policy and Protocol ("the Policy"). The DEIR included an analysis of GHG emissions and mitigation measures that is generally in accordance with the standard requirements of the MEPA GHG Policy and Protocol; however, the FEIR must address C.10

several issues. The DEIR did not address many of the comments and recommendations provided in the DOER ENF comment letter. I refer Massport to DOER's comment letter. In addition, discrepancies exist between the mitigation measures presented in Table 6-1 (Summary of Terminal E Modernization Beneficial Measures), the "Sustainability Features" narrative (Section 6.2.2), the Draft Section 61 Findings (Appendix B), and the information provided in the MEPA Greenhouse Gas Analysis Technical Report (Appendix G). C.11 It is unclear which GHG reduction measures have been committed to by the Proponent and which will continue to be evaluated. For example, many measures included in Table 6-1 which summarizes Massport's commitments to beneficial measures are subsequently referred to (in Section 6.2.2 of the narrative) as measures "to-be considered for their feasibility and applicability" during the preliminary design phase and later design phases. C.12 As indicated below, the Response to Comments must provide a detailed response to address each of the issues identified in DOER's comment letter and draft Section 61 Findings should be revised accordingly. C.13

The Base Case scenario is based on the 8th Edition of the Massachusetts Building Code that includes the International Energy Conservation Code 2012. The eQUEST v.3.64 modeling software was used to perform the GHG analysis. The DEIR indicates that Massport will build the Terminal E project to achieve LEED Silver or higher certification. The DEIR summarized the following design mitigation measures that were modeled in the GHG analysis and proposed for adoption by the Proponent:

- Improved building envelope (wall insulation of U-0.05, roof insulation of U-0.037, improved glazing of U-0.34, and reduced window to wall ration of 25%)
- Improved Air Handling Units (Variable Air Volume with reduced fan power per cfm; dual enthalpy air economizer to maximize benefit of using outdoor air to condition the building; automatic rest of fan static pressure and supply air temperature based on space loading to reduce fan power, cooling energy, and heating energy);
- Efficient water loops with reduced water supply temperature and wider return temperatures to reduce demand on the pumping and fan systems; and
- Reduced interior lighting power density (LPD) of 0.62 W/SF and reduced exterior lighting power of 9.3 kW.

C.14

These design measures were not identified in Table 6-1 or specifically identified in the draft Section 61 Findings. They should be incorporated into revised draft Section 61 Findings. The DEIR identifies the several energy conservation measures that were considered and eliminated primarily for concerns regarding constructability, ease of operations and maintenance and cost. Measures that were eliminated include automated reflective interior blinds to reduce solar heat gain, geothermal heat pumps, fan cycling based on occupancy load, and combined heat and power (CHP). C.15 I refer the Proponent to DOER' s comment letter which recommends further evaluation of CHP to address Terminal E's service water loads. Massport has indicated that conversion of the equipment at Logan's Central Heating and Cooling Plant will be evaluated as the equipment reaches the end of its useful life. C.16 I expect that further evaluation of CHP will be evaluated as part of that process and reported in future EDRs and ESPRS. C.17

Massport has committed to evaluate the following energy efficiency measures as project design progresses: dual box minimum, fin tube radiation, energy recovery wheel, dynamic V8 filtration, and implementation of a solar photovoltaic (pv) array. According to the DEIR, these C.18

measures could increase energy savings by 70% compared to the currently proposed project. C.18 However, the DEIR does not indicate why these mitigation measures cannot be incorporated into the project design at this time nor does it identify the additional analysis that would be required to inform a determination during subsequent design. C.19 In addition, Section 6.2.2 of the DEIR notes that Massport will investigate the feasibility of providing 2.5% of the project's power with on-site renewable energy through the use of Solar PV; and the Greenhouse Gas Analysis Technical Report (Appendix G) indicates that a 300 kW solar PV array may continue to be evaluated for inclusion in the project. As part of this evaluation, Massport should identify the total rooftop area available for a potential solar PV array and perform a financial feasibility analysis. To date Massport has installed a total of approximately 916 kW of solar PV at Logan and Hanscom airports. The FEIR should identify the basis for delaying a decision regarding installation of a solar PV project on the rooftop of Terminal E or, at a minimum, re-affirm the commitment to build it as "solar ready" until subsequent design phases. C.20 C.21

Stationary source GHG emissions associated with the energy use of the proposed Terminal E expansion are estimated to generate 5,850 tpy of CO_2 in the Base Case Scenario. Through the adoption of energy efficiency measures, the Preferred Alternative will reduce CO_2 emissions associated with the terminal expansion by 685 tpy, for a total of 5,165 tpy, or a 11.7 percent decrease. The GHG analysis also evaluated total net new GHG emissions from aircraft, GSE, airside ground access vehicles, and additional energy demand associated with the Terminal E expansion. The FAA's Aviation Environmental Design Tool (AEDT) and EPA's MOVES and NONROAD models were used to calculate the GHG emissions associated with the operations, including aircraft engines, GSE/auxiliary power units (APUs), and ground access vehicles. Changes to operations are estimated to reduce GHG emissions by an additional 5,371 tpy.

Climate Change Adaptation and Resiliency

The DEIR described the project's consistency with Massport's Disaster and Infrastructure Resiliency Planning (DIRP) Study and Floodproofing Design Guide. Terminal E will be above the projected 2070 coastal flood elevation. The Design Guide establishes Design Flood Elevations (DFEs) that are more conservative than existing building code requirements. The DEIR indicates that the first level of the project and associated utilities and critical equipment is generally located above the DFE. In areas where spaces must be located below the DFE, critical areas will be flood proofed or protected through use of the following measures: watertight shields on doors, windows, and louvers; exterior and interior membranes and sealants; drainage collection systems and sump pumps; early warning devices to monitor water levels; sealing electrical conduits and other utilities; back-flow preventer valves on drainage and sanitary sewer piping; and use of flood openings to equalize hydrostatic pressure. The DEIR notes that Massport has consulted with CZM regarding development of coastal resiliency design measures. Massport will continue consultations with CZM and MBTA and to review existing station vulnerabilities, as operations of the Blue Line and this station are important to support Massport HOV goals. Updates on this consultation and the design measures that are considered and/or incorporated into the design to improve the MBTA station's coastal resiliency should be provided in the EDR and ESPR documents. C.22

Air Quality

The DEIR included an analysis to determine whether and to what extent the proposed project will increase criteria pollutants. The analysis evaluated changes in emissions from aircraft engines, APUs and GSE, airside vehicles, and airport passenger and employee motor vehicles under the 2030 No-Build and 2030 Build scenarios. The FAA's AEDT was used to evaluate changes in emissions from aircraft ground operations. EPA's MOVES and NONROAD models were used to evaluate changes in emissions from ground support equipment and motor vehicle emissions. Results of the analysis indicate that total emissions of all pollutants will decrease within the project area under future conditions with the proposed project compared to future conditions without the project.

	Carbon Monoxide	Volatile Organic Compounds	Nitrogen Oxides	Sulfur Oxides	Particulate $Matter_{10}$	Particulate $Matter_{2.5}$
2030 No-Build	294 tpy	35 tpy	59 tpy	9 tpy	11 tpy	4 tpy
2030 Build Condition	268 tpy	33 tpy	33 tpy	6 tpy	10 tpy	3 tpy
Percent Change	-9%	-6%	-44%	-33%	-9%	-25%

The DEIR indicates that the reductions are largely due to the availability and use of gate-furnished electricity and air conditioning rather than APUs while parked at hardstands; reduced reliance on GSE to transport passengers, baggage, and cargo; and improved aircraft operational conditions (e.g., less congestion and delay) on the taxiways and aprons. The DEIR indicates that project complies with the applicable emission thresholds contained in the State Implementation Plan (SIP) and will not cause or contribute to a violation of the National Ambient Air Quality Standards (NAAQS). The DEIR quantified temporary construction-related impacts and confirmed that construction-related emissions will not exceed applicable emission thresholds.

Total air quality emissions from all sources at Logan Airport in recent years are significantly less than they were a decade ago; however, the 2014 EDR demonstrated that total emissions are increasing incrementally. The overall reduction is associated with industry trends of accommodating the demands of increasing passenger and cargo activity levels with fewer aircraft operations generating fewer emissions. Massport will continue to assess the applicability of emissions reduction measures to the extent practicable and report on air quality in the ESPR and the EDR. C.23

Noise

The DEIR asserts that the project will not result in any changes to the number and type of aircraft operations when compared to the Future No-Build Alternative. It indicates that demand is driven by economic and market factors; and, therefore, growth at Logan Airport will continue to occur regardless of the Terminal E project. Cumulative impacts will continue to be addressed through the ESPR and EDR. C.24

The DEIR included a noise evaluation which evaluated project-related ground noise conditions and the ability of the terminal extension to mitigate noise. The noise model also

identified how changes in the use of Terminal E gates and the North Cargo Area will affect ground noise levels. The extension of Terminal E has been designed to provide a noise barrier between the airport and the community. It will result in reduced noise levels at Jeffries Point, East Boston Memorial Park, and most residential areas in East Boston west of the ramp areas between Route 1A and Putnam Street. Specifically, the project will reduce noise from aircraft ground operations near Terminal E by five to 18 dB and from single event maximum noise levels by two to 15 dB in the Jefferies Point neighborhood. It will reduce noise from aircraft ground operations near Terminal E by three to 15 dB and from single event maximum noise levels by 1 to eleven dB in the Bremen Street area south of Putnam Street to Route 1A. The DEIR indicates that the project will not result in a significant noise increase within the Day-Night Average Sound Level (DNL) 65 dB contour.

I received many letters which identify a particular concern with concentrations of flight tracks and increased flight frequency due to the FAA's area navigation (RNAV) procedures. The primary purpose of the RNAV procedures is to increase safety and operational efficiency. As documented in the ESPR and annual EDR submittals, implementation of several of the RNAV procedures have generated increased noise complaints in some towns surrounding Logan Airport and I have received many comment letters from residents of the Town of Hull on this issue. The procedures themselves have resulted in aircraft at higher altitudes although patterns are concentrated over certain communities. I note that the FAA is implementing the RNAV program nation-wide. This program is separate from and unrelated to the Terminal E Modernization project. Through my review of the ESPR and EDRs, I am aware of The Boston Logan Airport Noise Study (BLANS)[2]; an ongoing and joint effort between the FAA, Massport, and the Logan Airport Citizen Advisory Committee (CAC). The RNAV procedures to Runways 27, 4L, and 33L were subject to review during Phase 3 of the BLANS[3]. The purpose of Phase 3, currently underway, is to identify opportunities to balance the use of Logan's runways and reduce persistent noise over communities. Flight operations are significantly lower than historic levels; however, I acknowledge that projected increases in flight operations will increase cumulative noise impacts compared to existing conditions. As noted previously, the ESPR and EDRs provide a forum and meaningful opportunities for public review of information and analysis related to these issues. I also encourage residents to contact their CAC representatives to identify additional methods to participate in improving the noise environment around Boston-Logan Airport.

C.25

C.26

Construction Period

The DEIR provided additional construction phase information (presented below in the Mitigation Measures section) to identify construction period impacts and measures to control construction traffic, air quality, noise, and water quality impacts.

Mitigation/Draft Section 61 Findings

The DEIR contained a separate chapter on mitigation measures and provided draft Section 61 Findings in an Appendix. It generally describes mitigation measures and contains commitments to mitigation. As noted earlier, additional clarity is necessary regarding those

C.27

[2]Information on the Boston Logan Airport Noise Study can be found at http://www.bostonoverflight.com/index.aspx
[3] These environmental documents can be found at http://www.bostonoverflight.com/phase3_documents.aspx

measures that are commitments and those that will be evaluated as project design progresses. This is particularly relevant to the GHG mitigation measures. The Proponent has committed to implement the following measures to avoid, minimize, and mitigate environmental impacts: C.27 Cont.

Operational Impacts

- The Terminal E expansion has been sited and will be designed to act as a noise barrier to the adjacent East Boston neighborhoods and Memorial Stadium park to the southwest of the North Apron. The new structures will have a minimum height of 45-ft above ground level.
- New gates will have electric power and pre-conditioned air to allow aircraft to plug in at gate rather than be serviced remotely to reduce need for on-board engine/auxiliary power unit operation, thereby reducing aircraft air emissions and GHG emissions.
- New gates will increase ramp efficiency and reduce movements on North Apron and the need to bus passengers between terminal and remote aircraft parking locations, thereby reducing ground transportation related air emissions and mobile source GHG emissions.
- Roadway and curb improvements which will improve vehicle flow and high-occupancy vehicle access.

Sustainable Design Features/Greenhouse Gas Emissions

- Improved building envelope (wall insulation of U-0.05, roof insulation of U-0.037, improved glazing of U-0.34, and reduced window to wall ratio of 25%).
- Improved Air Handling Units.
- Efficient water loops with reduced water supply temperature and wider return temperatures to reduce demand on the pumping and fan systems.
- Reduced interior lighting power density of 0.62 W/SF and reduced exterior lighting power of 9.3 kW.
- The roof design will incorporate materials with a minimum reflectance rating of 0.70 and emittance value of at least 0.75 for a minimum of 75% of the available roof area. Roofing materials will be non-glare to reduce heat island effect.
- Final design will incorporate infrastructure for collection, storage, and handling of recyclable materials.
- The contractor will be required to develop a construction waste management plan that requires diversion or reduction of construction waste by at least 75%.
- Massport will establish a project-specific goal for sourcing materials extracted, harvested, recovered, and or manufactured within New England.
- The project will be designed to achieve energy efficiencies of a minimum of 20% below the MA Energy Code.
- Continued investigation into the feasibility of supplying 2.5% of the project's power with on-site renewable energy systems.
- The project will be developed to accommodate rooftop solar.
- Project will include water conservation devices that reduce water use by 20% below the MA Plumbing Code.
- Project will incorporate occupancy sensors in all indoor areas to reduce electrical demand.

Construction Period

- Work hours will be limited to 7:00 AM to 5:00 PM unless constrained by operational conditions at the Airport.

- Adequate storage areas for construction supplies will be maintained on airport property.
- Soil Management Plan will be developed based on sub-surface investigations to address identification and disposal of contaminated materials.
- Stormwater Pollution Prevention Plan will be developed to keep sediment and contaminants out of the stormwater management system during construction.
- Management Plan for Dewatering will be developed (if required) to address requirements for testing, handling, and treatment prior to discharge of contaminated groundwater.
- Rodent control, inspection, monitoring, and treatment will be carried out before, during, and after completion of all foundation and utilities demolition and construction work. Rodent extermination prior to work will consist of treatment throughout the project area, including building exteriors and interiors and will continue throughout construction.
- Noise control techniques will be used to reduce noise from pile driving by at least 5 A-weighted decibels (dBA) below unmitigated levels through enclosing the point of impact for the pile drive; installation of an impact cushion between the pile drive and the pile; or requiring the application of energy-absorbing material to steel piles.
- Measures to reduce ground transportation impacts from project construction include:
    - Designated truck routes designed to keep construction-related traffic off of residential streets unless they are seeking construction-related access to or from local businesses.
    - Concrete production/batching will occur in existing plants with access to Route 1A or I-90 to reduce on-airport activities and to consolidate truck trips.
    - Construction companies will be encouraged to provide off-Airport parking for their employees and to provide shuttle services from these locations.
- The following measures will address construction phase air quality impacts:
    - Enforcement of construction vehicle anti-idling provisions;
    - Retrofitting diesel construction equipment with diesel oxidation catalysts and/or particulate filters;
    - Fugitive dust will be controlled via wetting or sweeping and all trucks hauling materials from the construction site will be covered.

<u>Responses to Comments</u>

The Response to Comments should contain a copy of this Certificate and a copy of each C.28
comment letter received on the DEIR. Comment letters may be provided electronically on a CD. C.29
As many of the comment letters identify similar concerns, the FEIR may contain a thematic C.30
response to comments to the extent that they are within MEPA jurisdiction. The response can
also refer to future EDRs and/or ESPRs to address issues that are not within the Scope of this C.31
review. This directive is not intended, and shall not be construed, to enlarge the scope beyond
what has been expressly identified in this Certificate. I recommend that Massport employ an C.32
indexed response to comments format, supplemented as appropriate with direct narrative
response. C.33

The response to comments section should address specific comments from DOER and a C.34
revised GHG analysis should be provided, if necessary to provide a meaningful response. The
Response to Comments should clarify GHG reduction measures and to demonstrate that GHG
emissions will be minimized, avoided, and mitigated to the maximum extent practicable. I expect C.35
that the FEIR will provide a comprehensive and thoughtful response to the DOER comment
letter and that Massport will consult with DOER prior to filing the Response to Comments. C.36

<u>Mitigation/Draft Section 61 Findings</u>

The Response to Comments should include revised draft Section 61 Findings which
should include a complete list of all mitigation measures developed through MEPA review of the C.37
project, including but not limited to, measures specifically incorporated into the terminal design
or operational measures to minimize GHG emissions. The Section 61 findings should clarify
which GHG mitigation measures are proposed as mitigation and which will continue to be
evaluated. It should reconcile the data contained in Table 6-1, Sustainability Features narrative in C.38
Section 6.2.2, and the information provided in the GHG Analysis Technical Report (Appendix
G). The revised draft Section 61 Findings should clarify the reduction in GHG emissions
(compared to the base case) that is being committed to as mitigation. The draft Section 61 C.39
Findings should also identify whether each mitigation commitment will be incorporated or
provided as part of Phase 1, Phase 2, or both phases of the project. C.40

To ensure that all GHG emissions reduction measures adopted by the Proponent in the
Preferred Alternative are actually constructed or performed, I require proponents to provide a
self-certification to the MEPA Office. Specifically, Massport must provide a certification to the C.41
MEPA Office signed by an appropriate professional (e.g., engineer, architect, transportation
planner, general contractor) indicating that the all of the mitigation measures proposed in the EIR
have been incorporated into the project. Alternatively, Massport may certify that equivalent
emissions reduction measures that collectively are designed to reduce GHG emissions by the
same percentage as the measures outlined in the EIR, based on the same modeling assumptions, C.42
have been adopted. The certification should be supported by plans that clearly illustrate where
GHG mitigation measures have been incorporated. For those measures that are operational in
nature (i.e. TDM) the Proponent should provide an updated plan identifying the measures, the
schedule for implementation and how progress towards achieving the measures will be obtained. C.43
The commitment to provide this self-certification in the manner outlined above should be
incorporated into the draft Section 61 Findings included in the EIR.

<u>Circulation</u>

In accordance with Section 11.16 of the MEPA Regulations and as modified by this
Certificate, Massport should circulate a hard copy of the FEIR to each State and City Agency C.44
from which the Proponent will seek permits. Massport must circulate a copy of the FEIR to all
other parties that submitted individual written comments. Per 301 CMR 11.16(5), the Proponent
may circulate copies of the FEIR to these other parties in CD-ROM format or by directing C.45
commenters to a project website address. However, Massport should make available a reasonable
number of hard copies to accommodate those without convenient access to a computer and
distribute these upon request on a first-come, first-served basis. Massport should send C.46
correspondence accompanying the CD-ROM or website address indicating that hard copies are
available upon request, noting relevant comment deadlines, and appropriate addresses for
submission of comments. A CD-ROM copy of the filing should also be provided to the MEPA
Office. A copy of the EIR should be made available for review at the following Libraries: Boston
Public Library – Main, Connolly, Orient Heights, Charlestown, and East Boston Branches, C.47
Chelsea Public Library, Winthrop Public Library, Revere Public Library, Everett Public Library,
Milton Public Library, and Hull Public Library.

Conclusion

Based on a review of the DEIR, consultation with State Agencies, and a review of comment letters, I have determined that the DEIR adequately and properly complies with MEPA and its implementing regulations. The Proponent may submit the Response to Comments and draft Section 61 Findings as the FEIR. C.48

September 16, 2016
Date

Matthew A. Beaton

Comments received:

7/28/2016	Greater Boston Convention & Visitors Bureau
8/1/2016	MassEcon
8/1/2016	Murphy, Hesse, Toomey & Lehane, LLP on behalf of the Town of Milton
8/3/2016	Local 22, Construction & General Laborers' Union
8/3/2016	Mary J. Ryan
8/3/2016	Air Impact Relief (AIR) via Aaron Toffler
8/5/2016	American Council of Engineering Compananies of Massachusetts (ACEC/MA)
8/5/2016	Associated Industries of Massachusetts (AIM)
8/10/2016	Conference of Boston Teaching Hospitals
8/11/2016	Boston Financial Services Leadership Council (BFSLC)
8/11/2016	Susanna Starrett
8/12/2016	Massachusetts Business Roundtable
8/14/2016	Magdalena Ayed
8/15/2016	Juan Ramos
8/15/2016	Linda Barber
8/15/2016	Sema Bekiroglu
8/16/2016	Town of Hull, Philip Lemnios, Town Manager
8/16/2016	Edward J. MacLean
8/16/2016	Renee MacLean
8/17/2016	Andrea White
8/17/2016	David Gardner
8/17/2016	Eugene Courier
8/17/2016	Evie Rose
8/17/2016	Herb Zeller
8/17/2016	Hull Neighbors for Quiet Skies
8/17/2016	Ira Fleishman
8/17/2016	Jen Hartnett-Bullen

8/17/2016	Joe Berkeley
8/17/2016	Juliet Floyd
8/17/2016	Karen Delano
8/17/2016	Kathy A. Beitler
8/17/2016	Linda Karoff
8/17/2016	Lisa Borden
8/17/2016	Maria Graceffa
8/17/2016	Mary Schultz
8/17/2016	Michael Doiron
8/17/2016	Michael Parks
8/17/2016	Philip R. Delano
8/17/2016	Richard Monarch
8/17/2016	Robert Stenberg
8/17/2016	Rosanne Bush
8/17/2016	Sallyann Kakas
8/17/2016	Sarah & Harold Chisholm
8/17/2016	Susan Ovans
8/17/2016	Thomas Hardey
8/17/2016	Tim Fox
8/17/2016	Val Woolley
8/18/2016	Betsy Lewenberg
8/18/2016	Jeff Kerr
8/18/2016	Karen Walsh
8/18/2016	Lloyd Emery
8/18/2016	Nancy Curtis
8/18/2016	Robyn Riddle
8/18/2016	Sheila Connor
8/18/2016	Stephen Etkind
8/18/2016	Nicole Dunn
8/18/2016	Patricia Hynes
8/18/2016	Mr. and Mrs. Tomassini
8/18/2016	Pamela Loring
8/18/2016	Canice Thynne
8/18/2016	John Brennan
8/18/2016	James & Barbara Barrow
8/18/2016	Rebecca and Tillmann Hein
8/18/2016	Stephanie B. Shafran
8/18/2016	Diane & George Nassopoulos
8/18/2016	Chris Maher
8/18/2016	Donna Goes
8/18/2016	Liz West
8/18/2016	Mary Devin
8/18/2016	Marjorie E. Wiseman
8/18/2016	Ellen

8/18/2016	Dorothy Tan
8/18/2016	Charleen Tyson
8/19/2016	Searose@comcast.net
8/19/2016	Town of Milton, Board of Selectmen
8/19/2016	Liz Kinkead
8/19/2016	Colleen MacDonald
8/19/2016	A Better City
8/19/2016	Steve West
8/19/2016	Lois Freedman
8/19/2016	Pam Sargent
8/19/2016	Paul Karoff
8/19/2016	Neill K. Ray
8/19/2016	Arlington and Belmont Representatives to the Logan CAC and Massport CAC
8/19/2016	Kathleen T. McCarthy
8/19/2016	William G. McCarthy
8/19/2016	Boston Harbor Now
8/19/2016	Andrew Schmidt
8/19/2016	Alex D. Doucette
8/19/2016	Massachusetts Department of Environmental Protection (MassDEP)
8/20/2016	Robert Banzett
8/22/2016	Association of Independent Colleges and Universities in Massachusetts (AICUM)
8/23/2016	Patricia McKinley
8/23/2016	Maria Argos Barber
8/23/2016	Joshua Acevedo
8/23/2016	Elizabeth Kay
8/25/2016	Elda Prudden
9/6/2016	Tom Carey
9/6/2016	Congressman Michael Capuano
9/7/2016	Greater Boston Chamber of Commerce
9/8/2016	Chris Marchi
9/8/2016	Steve Holt
9/8/2016	Caroline J. Mailhot
9/8/2016	Eneida Figueroa
9/8/2016	Sam Albertson
9/8/2016	Emily Hyman
9/8/2016	Peter I. Dunn
9/8/2016	Mimi L. Callum
9/8/2016	Massachusetts High Technology Council
9/8/2016	Jane O'Reilly
9/9/2016	Roy Avellaneda, Councilor at Large, Chelsea
9/9/2016	Susanna Starrett
9/9/2016	Michael, Allyson, Willa and Miles Simons
9/9/2016	Carlos Rosales
9/9/2016	Margaret Morris

9/9/2016	Kathleen McCauley
9/9/2016	Lindsay Rosenfeld
9/9/2016	John Antonellis
9/9/2016	John Casamassima
9/9/2016	Brian Gannon
9/9/2016	Celeste Ribeiro Myers
9/9/2016	Theresa Teshia Malionck
9/9/2016	Melissa Tyler
9/9/2016	Sandra Nijjar
9/9/2016	Joanne T. Pomodoro
9/9/2016	Air Impact Relief (AIR) via Aaron Toffler
9/9/2016	Alexis Pumphrey
9/9/2016	Maria Eugenia Corbo
9/9/2016	Magdalena Ayed
9/9/2016	Gail Miller
9/9/2016	Daniel Ryan
9/9/2016	Karen Sullivan
9/9/2016	John Walkey
9/9/2016	Edward, Camille & Renee MacLean
9/9/2016	Service Employees International Union (SEIU) 32BJ, District 615
9/9/2016	Alternatives for Community & Environment, Inc. (ACE)
9/9/2016	Judy Gates
9/9/2016	Mary Ellen Welch
9/9/2016	David Aiken
9/9/2016	Kannan Thiru
9/9/2016	Frederick Salvucci
9/9/2016	Neighbors United for a Better East Boston (NUBE)
9/9/2016	Angel C
9/9/2016	Rudi Seitz
9/9/2016	Alfred A. Pucillo
9/9/2016	Lydia Edwards
9/9/2016	Patricia J. D'Amore
9/9/2016	Alexis Daniels
9/9/2016	Tina Kelly
9/9/2016	Barbara McDonough
9/9/2016	Madeleine Steczynski
9/9/2016	Karen Connor
9/9/2016	Regina Marchi
9/9/2016	Roberto Verthelyi
9/9/2016	Vanessa Fazio
9/9/2016	Chrissy Holt
9/9/2016	Liz Nofziger
9/9/2016	Heather Kros
9/9/2016	June Krinsky-Rudder

9/9/2016	Kim Foltz
9/9/2016	Nancy Lee
9/9/2016	Jessica L. Curtis, JD
9/9/2016	Matthew Neave
9/9/2016	Cindy L. Christiansen
9/9/2016	Michael Passariello
9/9/2016	Elizabeth Kay
9/10/2016	Rob Pyles
9/10/2016	Jesse Borthwick
9/10/2016	Steve Passariello
9/10/2016	Carrie Van Horn
9/10/2016	John Tyler
9/10/2016	Kristen D'Avolio
9/10/2016	Craig Belaney
9/10/2016	Cindy M. López
9/10/2016	Laura Macias Grondin
9/10/2016	Sandra Downey
9/10/2016	Christopher A. Zeien
9/10/2016	Carol Doering
9/12/2016	Department of Energy Resources (DOER)
9/13/2016	Anthony M. Majahad
9/13/2016	State Senator Boncore, State Representative Madaro, and City Councilor LaMattina
9/13/2016	Mary Mitchell
9/14/2016	Olena Chuyan
9/14/2016	Julia Howington
9/16/2016	Karen Maddalena
9/16/2016	Boston Transportation Department (BTD)

MAB/PRC/prc

Copy of the Secretary of the Executive Office of Energy and Environmental Affairs Certificate issued for the Terminal E Modernization Project Final Environmental Assessment/Environmental Impact Report

This Page Intentionally Left Blank.

The Commonwealth of Massachusetts

Executive Office of Energy and Environmental Affairs
100 Cambridge Street, Suite 900
Boston, MA 02114

Charles D. Baker
GOVERNOR

Karyn E. Polito
LIEUTENANT GOVERNOR

Matthew A. Beaton
SECRETARY

Tel: (617) 626-1000
Fax: (617) 626-1081
http://www.mass.gov/eea

November 10, 2016

CERTIFICATE OF THE SECRETARY OF ENERGY AND ENVIRONMENTAL AFFAIRS
ON THE
FINAL ENVIRONMENTAL IMPACT REPORT

PROJECT NAME	: Terminal E Modernization
PROJECT MUNICIPALITY	: East Boston
PROJECT WATERSHED	: Boston Harbor
EEA NUMBER	: 15434
PROJECT PROPONENT	: Massachusetts Port Authority
DATE NOTICED IN MONITOR	: October 5, 2016

As Secretary of Energy and Environmental Affairs, I hereby determine that the Final Environmental Impact Report (FEIR) submitted on this project **adequately and properly complies** with the Massachusetts Environmental Policy Act (MEPA; M.G.L. c.30, ss.61-62I) and with its implementing regulations (301 CMR 11.00). As noted in my Certificate on the Draft EIR (DEIR) issued September 16, 2016, the DEIR fully responded to the Scope contained in the Certificate on the Environmental Notification Form (ENF) and therefore the scope of the Final EIR (FEIR) was limited to a response to comments and draft Section 61 Findings.

Comments received on the FEIR continue to identify concerns regarding existing airport operations and noise levels and potential increases with long-term growth. I have received comment letters from elected officials (including U.S. Congressman Michael E. Capuano, the Milton Board of Selectmen, and Revere Mayor Brian Arrigo), state agencies, environmental advocacy groups, businesses, and residents. The issue of cumulative airport-wide impacts, particularly noise and air quality, is not new to the review of projects at Logan Airport. As noted in past Certificates, the EIR is not intended to address broad concerns associated with airport operations and growth. The venue for addressing cumulative environmental impacts is through the Environmental Status and Planning Reports (ESPR) and Environmental Data Reports (EDR). Through these reports, Logan Airport is subject to comprehensive and regular MEPA review, including opportunities for public comment on the cumulative impacts. This regular updating and reporting on planning and cumulative impacts is unique among State Agencies. It reflects the challenge and complexity of managing and modernizing Logan Airport within a dense, urban

area. It recognizes that the proximity of communities to the Airport warrants an enhanced level of public engagement and a concerted, long-term effort to minimize and mitigate impacts.

Subsequent ESPRs and EDRs will update the cumulative impacts of passenger growth and associated ground and aircraft operations based on revised forecasts and update and revise environmental management plans to address impacts. Future submittals will continue to document potential impacts and trends and propose measures to implement the broad goal of maintaining or reducing Logan's overall environmental impacts, even as annual passenger volumes rise in the future. The next ESPR will analyze calendar year 2016 and will likely be filed in 2017 or 2018 and the next EDR will analyze calendar year 2015 and will likely be filed in the fall of 2016.

I note many comments identify a particular concern with concentrations of flight tracks due to the Federal Aviation Administration's (FAA) area navigation (RNAV) procedures. The primary purpose of the RNAV procedures is to increase safety and operational efficiency. As documented in the ESPR and annual EDR submittals, implementation of several of the RNAV procedures have generated increased noise complaints in some towns surrounding Logan Airport. The procedures themselves have resulted in aircraft at higher altitudes and concentration of flight patterns over certain communities. I note that the FAA is implementing the RNAV program nation-wide. This program is separate from and unrelated to the Terminal E Modernization project. Nonetheless, I am aware that Massport and the FAA recently signed a Memorandum of Understanding (MOU) to frame a new process for analyzing opportunities to incrementally reduce noise through changes or amendments to Performance Based Navigation, including RNAV procedures. I commend Massport and the FAA for establishing this agreement, which is a unique project between the FAA and an airport operator. Massport has indicated that this process will incorporate community outreach and public input. I expect that updates on this process will be provided in in future ESPRs and EDRs which will provide an additional forum and meaningful opportunities for public review of information related to these issues.

Over the past year, Massport has engaged in a concerted outreach effort with elected officials, municipalities, and community groups to identify and discuss potential Massport projects, including but not limited to, Terminal E. Massport created the Logan Airport Impact Advisory Group (IAG) to solicit comment and to identify and prioritize projects and programs of significance to the IAG. I commend Massport for its outreach efforts and encourage Massport to continue a productive dialogue with interested stakeholders, including through the IAG.

I have received comments that identify concerns with other potential Massport projects, including the potential parking garage identified in the DEIR, which would require an amendment to the Logan Airport Parking Freeze Regulation (310 CMR 7.30). As noted in the DEIR and previous Certificate, the potential parking garage will be subject to MEPA review pursuant to 301 CMR (6)(a)(7) because it will be constructed by a State Agency and will include construction of 1,000 or more new parking spaces. Subsequent MEPA review will include review of potential environmental impacts and development of project-specific impact avoidance, minimization, and mitigation measures.

Project Description

The project proposes modernizing Boston-Logan International Airport's John A. Volpe International Terminal (Terminal E) with a 560,000-square foot (sf) addition that corrects facility deficiencies and accommodates current and anticipated passenger volumes. The project includes three gates which previously underwent MEPA review (International Gateway Project, EEA #9791) but were not constructed, and four additional aircraft gates, passenger holdrooms, concourse, concessions, and passenger processing areas. The project includes Customs and Border Patrol (CBP) and Federal Inspection Services (FIS) facilities to replace and expand FIS facilities that were originally reviewed under MEPA (Terminal B, Pier A Improvements/Satellite FIS Facility, EEA #12235) but also not constructed. The project includes a direct pedestrian connection between Terminal E and the MBTA Blue Line Airport Station.

Terminal E was constructed in 1974 with 12 gates and served 1.4 million annual passengers. In 2014, it served approximately five million passengers. The DEIR indicated that the current level of passenger activity routinely causes severe congestion in the terminal at peak times, leading to greatly reduced customer service, and inefficient operations in the terminal and gates. According to the DEIR, gate congestion leads to airside delays and inefficiencies on the North Apron. When no gates are available, arriving aircraft and passengers are held on the apron. The DEIR indicated that aircraft must use remote parking facilities at hardstands in the North Cargo Area and passengers are bused to the terminal during peak periods when there are insufficient gates. The DEIR built upon the information presented in the ENF regarding challenges associated with current operations at Terminal E. Massport has clearly demonstrated the need for the project and made a compelling case for the expansion.

The project is proposed in two phases. Phase 1 will be constructed from 2018 – 2022 and will include construction of four new gates with associated passenger holdrooms and elevators/escalators to relieve existing deficiencies and accommodate interim growth. A partial new concourse will be constructed to allow for future expansion to a seven-gate facility at full build-out. Phase 1 will not require modifications to roadway realignment. Phase 2 will be built by 2028 and will provide three additional gates and the MBTA connection. The project will be fully constructed and operational by 2030.

The project will displace ground service equipment (GSE), other airside activities, existing surface parking, the cell phone lot, and the gas station which will be relocated within existing airport boundaries. Relocation of ground facilities that conflict with the new concourse location, including the gas station, will occur in Phase 1.

Environmental Status and Planning Report (ESPR) and Environmental Data Reports (EDRs)

The MEPA environmental review process for Logan Airport occurs on two levels: airport-wide and project-specific. The ESPR and EDR provide a "big picture" analysis of the environmental impacts of current and anticipated levels of airport-wide activities (including aircraft operations and passenger activity), and presents comprehensive strategies to avoid, minimize and mitigate impacts. The ESPR is generally updated on a five-year basis; the most recent ESPR for the year 2011 was filed in April 2013 and it contained updated passenger activity levels and aircraft operations forecasts through 2030. EDRs evaluate environmental conditions for the reporting year as compared to the previous year and are filed in the years

between ESPRs. The most recent EDR for the year 2014 was filed in October 2015. The EDR provided a comprehensive cumulative analysis of the effects of all Logan Airport activities based on actual passenger activity and aircraft operation levels in 2014 and presents environmental management plans for addressing environmental impacts. The ESPR is supplemented by (and ultimately incorporates) the EDRs and the detailed analyses and mitigation commitments that emerge from project-specific reviews. This process provides a comprehensive and continuous review of airport programs, projects, environmental impacts and associated data.

The 2015 EDR Scope includes, but is not limited to, reporting on noise, air quality, and long-term parking management. The 2015 EDR and 2016 ESPR should reflect the proposed connection to the Airport Station, provide updates on the planning and design of the connection, and identify the anticipated ridership, changes in the HOV mode share, and ground access planning considerations.

The MEPA regulations (Section 11.06(2)) indicate that during the course of an ENF review I may review any relevant information from any other source to determine whether to require an EIR, and, if so, what to require in the Scope. To provide context for this project-specific review and because many issues raised by commenters relate to airport-wide operations and impacts, this Certificate refers to documents from the ESPR process (EEA#3247/5146).

Logan Airport and Project Site

The Airport boundary encompasses approximately 2,400 acres in East Boston and Winthrop, including approximately 700 acres underwater in Boston Harbor. The Airport is surrounded on three sides by Boston Harbor and is accessible by two public transit lines and the roadway system. The airfield is comprised of six runways and approximately 15 miles of taxiway. Logan Airport has four passenger terminals, A, B, C, and E, each with its own ticketing, baggage claim, and ground transportation facilities.

Terminal E is located adjacent to the North Cargo Area, closest to the MBTA Blue Line Airport Station. Land uses in the area of the proposed project include UPS aircraft parking and loading area, the airport's Remain Over Night aircraft parking area, the North Cargo Area equipment storage area, a building occupied by United Parcel Service (UPS), the MBTA Blue Line Airport Station, airport roadways, various short-term and cell phone parking lots, and a gas station.

The project site is located within the coastal zone of Massachusetts. The entirety of the project site is comprised of previously disturbed impervious area. It is not located in Priority or Estimated Habitat as mapped by the Division of Fisheries and Wildlife's (DFW) Natural Heritage and Endangered Species Program (NHESP). The project site does not contain wetland resource areas regulated pursuant to the Wetland Protect Act and its implementing regulations (310 CMR 10.00).

The ENF identified the following projects within the vicinity of Terminal E that have been reviewed under MEPA: Terminal A Replacement (EEA#9329), Terminal E Modifications (EEA#9324), Federal Inspection Services (FIS) Facility and West Concourse Project / International Gateway (EEA#9791), and Terminal B, Pier A Improvements/Satellite FIS Facility (EEA#12235).

Permitting and Jurisdiction

The project is undergoing MEPA review and required an ENF pursuant to 301 CMR 11.03(6)(b)(6) because it will be undertaken by a State Agency and results in the expansion of an existing terminal at Logan Airport by greater than 100,000 sf.

The project requires a Sewer Permit Modification from the Boston Water and Sewer Commission (BWSC) and may require an Industrial User Permit from the Massachusetts Water Resource Authority (MWRA). The project may be subject to Massachusetts Office of Coastal Zone Management (CZM) federal consistency review.

The project requires approval by the Federal Aviation Administration (FAA) for changes to the Airport Layout Plan and, therefore, requires an Environmental Assessment (EA) under the National Environmental Policy Act (NEPA). The project also requires a National Pollutant Discharge Elimination System (NPDES) General Permit for Construction from the U.S. Environmental Protection Agency.

Because the project will be undertaken by a State Agency, MEPA jurisdiction is broad in scope and extends to all aspects of the project that may cause Damage to the Environment, as defined in the MEPA regulations.

Environmental Impacts and Mitigation

As described in the ENF, the project includes construction of approximately 500,000 to 700,000 sf of new floor area (for a maximum 1,500,000 sf total), and will increase both water consumption and wastewater generation by approximately 25,600 gallons per day (76,800 gpd total). The project will not create new impervious area and will eliminate approximately 60 parking spaces. The DEIR indicated that the project will accommodate existing and forecasted passenger levels and operations and, therefore, will not increase passenger enplanements or vehicle trips.

Measures to avoid, minimize and mitigate project impacts include reducing air emissions, greenhouse gas (GHG) emissions, and energy consumption compared to existing conditions by improving access to gate plug-ins, pre-conditioned air, and reducing busing operations. In addition, the building is designed to act as a noise barrier to the adjacent residential areas and Memorial Stadium Park.

Review of the FEIR

The FEIR was responsive to the scope issued in the Certificate on the DEIR. It included responses to comments filed on the DEIR and revised draft Section 61 Findings that outline Massport's mitigation commitments for the project. The FEIR included an Executive Summary of the DEIR both in English and a translated version in Spanish. The FEIR included the FAA's revised draft Finding of No Significant Impact/Draft Record of Decision (Draft FONSI/DROD) which was updated since the DEIR. This Certificate applies to the MEPA review of the project.

MEPA review cannot and does not restrict the ability of the federal government to act on those aspects of the project subject to the National Environmental Act (NEPA).

The only change to the project since the review of the DEIR is incorporation of additional mitigation measures to reduce GHG emissions (described below). No other changes to project programming, layout, or anticipated environmental impacts are identified. State Agencies did not request additional MEPA review or identify further analysis that would warrant additional MEPA review.

Response to Comments

The Response to Comments contained a copy of the DEIR Certificate and a copy of each comment letters received on the DEIR. A total of 186 comment letters were provided on the DEIR, of which 120 consisted of form letters. The FEIR contained a summary table that identified each commenter, the issues identified in their comment letter, and the corresponding section(s) of the FEIR to assist in locating the response. The FEIR contained both thematic responses to frequent comments and separate responses to individual comments. I commend Massport for providing a comprehensive response to comments and recognize the time and effort that Massport has invested in the preparation of the FEIR.

Responses to individual comments were provided for state agencies, municipalities, elected officials, and key stakeholders. Thematic responses were provided for the following categories: alternatives, cumulative impacts, environmental justice, ground transportation, health effects, induced growth, MEPA process, mitigation, noise, parking, regionalization, resiliency, RNAV departure procedures, and stakeholder outreach. Many of the comments received on the DEIR identify concerns related to existing airport operations and noise levels and potential increases in impacts associated with long-term growth. As noted in past Certificates, the EIR is not intended to address broad concerns associated with airport operations and growth. The venue for addressing cumulative environmental impacts is through the Environmental Status and Planning Reports (ESPR) and Environmental Data Reports (EDR). The Response to Comments refers to future EDRS and/or ESPRs to address these issues which are not within the Scope of this review.

As required in the Scope, the response to comments section of the FEIR provided a direct response to comments from the Department of Energy Resources (DOER) that clarified the GHG reduction measures proposed for the project and included a revised GHG analysis. Based on the revised analysis, the project incorporated two additional and significant mitigation measures: a 25,000 square feet (sf) rooftop solar photovoltaic (PV) system (300 kW) and solar thermal heating of domestic hot water for public restrooms. These two measures will reduce GHG emissions by 363 tons per year (tpy) compared to the proposed as presented in the DEIR. With these additional mitigation measures, the Preferred Alternative will reduce CO_2 emissions associated with the terminal expansion by 1,390 tpy, for a total of 3,818 tpy, or a twenty-seven percent decrease. The FEIR revised the draft Section 61 findings to reflect the revised mitigation measures.

The FEIR also evaluated and quantified the potential GHG reduction associated with the following five mitigation measures: Dual Box Minimum, Fin Tube Radiation, Energy Recovery Wheel, Dynamic V8 Filtration, and additional 50,000 sf of solar PV panels. The incorporation of

these measures would reduce GHG emissions by fifty-percent. Massport has committed to continue evaluating these measures as design progresses. The FEIR also included an analysis of additional wall, roof, and fenestration improvements which indicated they are not effective GHG reduction strategies for the project. It included an evaluation of solar thermal for the concession-area hot water; however this measure remains under deliberation as concession needs are still being developed.

I acknowledge and appreciate the consultation between Massport and DOER which has resulted in the identification and commitment to additional and significant GHG emission reductions.

Mitigation/Draft Section 61 Findings

The FEIR identified measures to avoid, minimize, and mitigate environmental impacts and included draft Section 61 Findings for use by State Agencies. The FEIR clarified that the timing and responsibility for implementation of each measure. The direct connection to the Airport MBTA Blue Line Station, full sound barrier benefits associated with extending the full width of the terminal, and curb improvements will be implemented during the second phase of the project. The other energy reduction and greenhouse gas reduction measures will be implemented in the first phase of the project. Measures to avoid, minimize, and mitigate environmental impacts include:

Operational Impacts

- The Terminal E expansion has been sited and will be designed to act as a noise barrier to the adjacent East Boston neighborhoods and Memorial Stadium park to the southwest of the North Apron. The new structures will have a minimum height of 45-ft above ground level.
- New gates will have electric power and pre-conditioned air to allow aircraft to plug in at gate rather than be serviced remotely to reduce need for on-board engine/auxiliary power unit operation, thereby reducing aircraft air emissions and GHG emissions.
- New gates will increase ramp efficiency and reduce movements on North Apron and the need to bus passengers between terminal and remote aircraft parking locations, thereby reducing ground transportation related air emissions and mobile source GHG emissions.
- Roadway and curb improvements which will improve vehicle flow and high-occupancy vehicle access.
- Construction of a weather-protected pedestrian connector from the Terminal to the MBTA Airport Blue Line Station (proposed as part of Phase 2).

Sustainable Design Features/Greenhouse Gas Emissions

- Project will seek LEED Certification at the Silver level rating or better and meet or exceed the goals of the MA LEED Plus program.
- Improved building envelope (wall insulation of U-0.05, roof insulation of U-0.037, improved glazing of U-0.34, and reduced window to wall ratio of 25%).
- Improved Air Handling Units.
- Efficient water loops with reduced water supply temperature and wider return temperatures to reduce demand on the pumping and fan systems.
- Reduced interior lighting power density of 0.62 W/SF and reduced exterior lighting power of 9.3 kW.

- The roof design will incorporate materials with a minimum reflectance rating of 0.70 and emittance value of at least 0.75 for a minimum of 75% of the available roof area. Roofing materials will be non-glare to reduce heat island effect.
- Final design will incorporate infrastructure for collection, storage, and handling of recyclable materials.
- Massport will establish a project-specific goal for sourcing materials extracted, harvested, recovered, and or manufactured within New England.
- The project will be designed to achieve energy efficiencies of a minimum of 20% below the MA Energy Code.
- The project will reduce operational-related GHG emissions associated with the Project by a minimum of 30%.
- The project will include water conservation devices that reduce water use by 20% below the MA Plumbing Code.
- The project will be built 'solar ready' to accommodate rooftop solar.
- The Terminal E rooftop will include a minimum 25,000 sf of rooftop solar PV (300 kW).
- Solar thermal PV system will be used to provide hot water for the restrooms.
- Project will incorporate occupancy sensors in all indoor areas to reduce electrical demand.
- Continue to evaluate feasibility of the following measures as design progresses: Energy Recovery Wheel, additional rooftop solar PV, Dual Box Minimum, and Dynamic Filtration.
- A self-certification will be provided to the MEPA office upon completion of the project construction signed by an appropriate professional (e.g. civil engineer, traffic engineer, architect, general contractor) indicating that all of the GHG mitigation measures, or equivalent measures that are designed to collectively achieve the proposed stationary source GHG emission reduction committed to in the FEIR, have been incorporated into the project.

Air Quality

- Project will result in a decrease in carbon monoxide (CO) emissions in the area of Terminal E and the associated aircraft apron by approximately 9%, nitrogen oxide (NO_X) emissions by approximately 44%, and sulfur oxides (SO_X) emissions by approximately 33%.
- Project will result in decrease of Volatile Organic Compounds (VOCs) in the project area by approximately 6% and particulate matter (PM_{10} and $PM_{2.5}$) by approximately 9% and 25%, respectively.

Construction Period Impacts

- Development of a construction waste management plan that requires diversion or reduction of construction waste by a minimum of 75%.
- Use of high efficiency space heating/cooling systems in temporary work spaces.
- Work hours will be limited to 7:00 AM to 7:00 PM unless constrained by operational conditions at the Airport. The sound levels from construction activities will employ measures to voluntarily comply with the City of Boston's noise standards.
- Soil Management Plan will be developed based on sub-surface investigations to address identification and disposal of contaminated materials.
- Implement Indoor Air Quality (IAQ) Management Plan during construction.

- Stormwater Pollution Prevention Plan will be developed to keep sediment and contaminants out of the stormwater management system during construction.
- Soil and groundwater management during construction will be conducted in accordance with the appropriate submittals (i.e., Release Abatement Measures, Immediate Response Actions, and/or Safety Management Plans) and subsurface contamination (if encountered) will be remediated in compliance with the Massachusetts Contingency Plan.
- Measures to reduce impacts from the approximately 60 daily truck trips associated with project construction include:
    - Construction-related traffic will be required to use the North Gate using only state and federal highways and the airport roadway network to keep construction-related traffic off of local East Boston roadways.
    - Use of police detail, as necessary, to manage traffic and ensure public safety.
    - Construction companies will be required to provide off-Airport parking for their employees and to provide shuttle services or other HOV service from these locations.
- The following measures will address construction phase air quality impacts:
    - Contractor will comply with MassDEP's Clean Air Construction Initiative regarding installation of emission control devices (such as diesel oxidation catalyst and/or particulate filters) on equipment;
    - Enforcement of construction vehicle anti-idling provisions;
    - Retrofitting diesel construction equipment with diesel oxidation catalysts and/or particulate filters;
    - Fugitive dust will be controlled via wetting or sweeping and all trucks hauling materials from the construction site will be covered.

Conclusion

Based on a review of the FEIR, comment letters, and consultation with State Agencies, I find that the FEIR adequately and properly complies with MEPA and its implementing regulations. Future EDRs and ESPR submittals will continue to document potential impacts and trends and propose measures to implement the broad goal of maintaining or reducing Logan's overall environmental impacts, even as annual passenger volumes rise in the future. Massport and State Agencies should forward copies of the final Section 61 Findings to the MEPA Office for publication in accordance with 301 CMR 11.12.

November 10, 2016
Date

Matthew A. Beaton

Comments received:

10/08/16 David Waite
10/10/16 Sarah James
10/10/16 Peter Houk
10/15/16 Marjorie Smith
10/18/16 Lahra Tillman

10/18/16 Maureen Wing
10/18/16 Reena Freedman
10/18/16 John Vitagliano
10/21/16 David Bowen
10/21/16 Ken Bader
10/23/16 Estella and David Keefer
10/24/16 Carolann Barrett
10/25/16 Shelia Mooney
10/27/16 Luke Preisner
10/28/16 Frederick Salvucci
10/28/16 Mary Ryan
10/31/16 Amelia Kantrovitz
10/31/16 Caslynn Carambelas and Vaishal Patel
10/31/16 Elizabeth Gazda
10/31/16 Juan Carlos Garzon
10/31/16 Stephen Raymond
10/31/16 Scott Johnson
10/31/16 Julie Vail
11/01/16 Sema Bekiroglu
11/01/16 Catherine Stacy
11/01/16 Cady Landa
11/01/16 Dominica Bonanno
11/01/16 Congressman Michael Capuano
11/01/16 Hull Neighbors for Quiet Skies
11/02/16 Tonya Saccardo
11/02/16 Robert Saccardo
11/02/16 Milton Board of Selectmen
11/02/16 Matthew Stachler, M.D., Ph.D.
11/03/16 Barbara L Lawrence
11/03/16 Magdalena Ayed
11/03/16 City of Lynn, Bill Bochnak, Massport CAC & Logan Airport Member
11/03/16 G. Bernadette Cantalupo, 156 Porter St.
11/03/16 William Schneiderman
11/04/16 Gail Miller
11/04/16 Massachusetts Department of Environmental Protection (MassDEP)
11/04/16 Chris Marchi
11/04/16 James Linthwaite
11/04/16 Catherine Stalberg
11/04/16 Mary Ellen Welch (1 of 2)
11/04/16 Mary Ellen Welch (2 of 2)
11/04/16 Department of Energy Resources (DOER)
11/04/16 Vickie Livermore
11/04/16 City of Revere, Mayor Arrigo
11/04/16 AIR Inc., Aaron Toffler
11/04/16 Deborah Hartman
11/04/16 Mimi Callum
11/04/16 Andrea Vilanova
11/04/16 Ann Jansen
11/04/16 John Casamassima
11/04/16 Alyssa Vangeli
11/04/16 Tara Ten Eyck
11/04/16 Boston Harbor Now

11/07/16 28 Form Letters from Residents of the Porter156 Condominium Association
11/07/16 Jesse Borthwick

MAB/PRC/prc

This Page Intentionally Left Blank.

Copy of the Secretary of the Executive Office of Energy and Environmental Affairs Certificate issued for the Logan Airport Parking Project Environmental Notification Form

This Page Intentionally Left Blank.

The Commonwealth of Massachusetts

Executive Office of Energy and Environmental Affairs
100 Cambridge Street, Suite 900
Boston, MA 02114

Charles D. Baker
GOVERNOR

Karyn E. Polito
LIEUTENANT GOVERNOR

Matthew A. Beaton
SECRETARY

Tel: (617) 626-1000
Fax: (617) 626-1081
http://www.mass.gov/eea

May 5, 2017

CERTIFICATE OF THE SECRETARY OF ENERGY AND ENVIRONMENTAL AFFAIRS
ON THE
ENVIRONMENTAL NOTIFICATION FORM

PROJECT NAME	: Logan Airport Parking Project
PROJECT MUNICIPALITY	: Boston
PROJECT WATERSHED	: Boston Harbor
EEA NUMBER	: 15665
PROJECT PROPONENT	: Massachusetts Port Authority (Massport)
DATE NOTICED IN MONITOR	: April 5, 2017

Pursuant to the Massachusetts Environmental Policy Act (MEPA; M.G. L. c. 30, ss. 61-62I) and Section 11.03 of the MEPA regulations (301 CMR 11.00), I have reviewed the Environmental Notification Form (ENF) and hereby determine that this project **requires** the preparation of a Mandatory Environmental Impact Report (EIR).

Project Description

As described in the ENF, the project includes the construction of 5,000 additional commercial parking spaces at the Logan International Airport (the "Airport"). The parking spaces will be located on additional floors within the existing Economy Garage and at a new parking garage in the location of the existing Terminal E surface parking lot. Potential phasing of the project and design of the parking structures is being developed; however, the ENF indicates that all 5,000 additional commercial parking spaces will be operational between 2022 and 2024. The ENF indicates that the parking spaces are intended to accommodate existing and anticipated air passenger demand for parking at the Airport. According to the ENF, the project will reduce

drop-off/pick-up activity at the Airport and will reduce regional air passenger-related vehicle miles traveled (VMT) and associated air emissions.

In addition to the overall air quality benefits, the ENF indicates that Massport is considering additional high occupancy vehicle (HOV) mode improvement measures in conjunction with this project. These include enhancing Logan Express bus service through expanded parking at existing locations and increased frequency of service and expanding the Logan Express service area to new suburban locations and urban/downtown areas based on the success of the Back Bay Logan Express pilot program. The ENF also indicates that Massport is considering purchasing additional Silver Line buses to increase service capacity to the Airport.

Project Background and Context

The number of commercial and employee parking spaces allowed at Logan Airport is regulated by the Massachusetts Department of Environmental Protection (MassDEP) through the Massport/Logan Airport Parking Freeze (310 CMR 7.30), an element of the Massachusetts State Implementation Plan (SIP) under the federal Clean Air Act. The ENF indicates that peak day demand for on-Airport parking has been increasing, resulting in daily demand frequently nearing the Logan Airport Parking Freeze cap. Massport has filed this ENF concurrent with MassDEP's issuance of a draft regulation to amend the Parking Freeze. At Massport's request, the amendment would allow the creation of an additional 5,000 commercial parking spaces at the Airport. The MassDEP public comment period on the proposed regulations will close on May 8th, after this Certificate is issued.

As currently drafted, the regulations would increase the Logan Airport commercial parking freeze limit by 5,000 spaces (from 18,640 to 23,640 spaces) and would increase the total cap to 26,088 commercial and employee parking spaces (comprised of 23,640 commercial spaces and 2,448 employee parking spaces). The draft regulations include a requirement that Massport complete the following studies, each within 24 months of when the final regulations are promulgated, to identify ways to further support alternative transit options to the airport:

1. A study to evaluate the costs, feasibility, and effectiveness of potential measures to improve HOV access to the Airport. The study would consider, among other things, possible improvements to Logan Express bus service and the benefits of adding Silver Line buses with service to the Airport.
2. A study of costs and pricing for different modes of transportation to and from the Airport to identify a pricing structure and the use of revenues so generated to promote the use of HOV modes of transportation by Airport air travelers and visitors. The study will include evaluation of short-term and long-term parking rates and their influence on different modes of Airport transportation.
3. A study of the feasibility and effectiveness of potential operational measures to reduce non-high occupancy vehicle pick-up / drop-off modes of transportation to Logan Airport, including an evaluation of emerging ride-sharing and transportation network company modes.

This Project is contingent upon MassDEP amending the Logan Airport Parking Freeze regulation and EPA approval of an amendment to the SIP. If the regulations are not amended, the

Logan Airport Parking Project cannot proceed. The MassDEP regulatory amendment would provide the larger framework of the Logan Airport Parking Freeze, while project-specific impacts and mitigation measures will be analyzed through the MEPA review process for the Logan Airport Parking Project.

Logan Airport and Project Site

The Airport boundary encompasses approximately 2,400 acres in East Boston and Winthrop, including approximately 700 acres underwater in Boston Harbor. The airfield is comprised of six runways and approximately 15 miles of taxiway. Logan Airport has four passenger terminals, A, B, C, and E, each with its own ticketing, baggage claim, and ground transportation facilities. The Airport is surrounded on three sides by Boston Harbor and is accessible by two public transit lines and the roadway system. The preferred locations for the parking structures are the Economy Garage and the Terminal E surface parking lot. The Economy Garage is located in the northwest portion of the Airport campus at the intersection of Service Road and Prescott Street. It is comprised of two levels and provides over 2,700 spaces. The Terminal E surface parking lot is located within the Airport interior and adjacent to Terminal E.

As described in the ENF, the airport is well-served by public transportation and approximately 30% of travelers accessing the Airport arrive via HOV modes. Specifically, the Airport is served by several Massachusetts Bay Transportation Authority (MBTA) public transit routes, including Blue and Silver Lines for the rapid transit system, commuter ferry service, and local and express bus routes. Specifically, Massport provides free shuttle service between the Blue Line Airport Station and all Airport terminals and subsidizes the Silver Line Logan Airport Route (SL1) by providing free outbound Silver Line trips from the Airport on eight Silver Line buses purchased for this route by Massport. Massport also operates an extensive Logan Express Bus service, serving five locations. The airport is also served by other private express bus service and intercity bus service as part of the range of HOV modes available for ground access.

The Economy Garage and the Terminal E parking lot sites are both located within the coastal zone of Massachusetts. Both locations are comprised of previously disturbed impervious area. They are not located in Priority or Estimated Habitat as mapped by the Division of Fisheries and Wildlife's (DFW) Natural Heritage and Endangered Species Program (NHESP). The parking lot sites do not contain wetland resource areas regulated pursuant to the Wetland Protect Act and its implementing regulations (310 CMR 10.00).

Environmental Impacts and Mitigation

The project includes construction of 5,000 new commercial parking spaces at two locations. The project is located within previously altered impervious area and will not create new impervious area. According to the ENF, the new spaces are intended to accommodate existing and anticipated air passenger demand for parking at the Airport while minimizing pick-up and drop-off activity and decreasing regional air passenger-related VMT and associated vehicle emissions. Specifically, the ENF indicates that the project will reduce carbon dioxide (CO_2), volatile organic compounds (VOC), and oxides of nitrogen (NO_x) emissions by

approximately 25% in 2022 and approximately 20% in 2030 as compared to the future No-Build Alternative.

The ENF indicates that expanded overall HOV capacity will be necessary to maintain the current HOV mode share as total passenger trips increase. In addition to the overall project benefits and HOV related measures proposed as part of the amendment to the Logan Parking Freeze, the ENF indicates that Massport is considering undertaking additional HOV measures in conjunction with the construction of the proposed 5,000 parking spaces. These include: enhancing existing Logan Express scheduled bus service; expanding Logan Express scheduled bus service; exploring Logan Express scheduled bus service in the urban/downtown area; and investing in additional MBTA Silver Line buses. In addition, the parking garages may be designed to be certified in the new "Parksmart" program, which applies Leadership in Energy and Environmental Design (LEED) sustainability strategies to structured parking facilities. The ENF indicates that measures to avoid, minimize, and mitigate project impacts will be further defined in the DEIR.

Jurisdiction and Permitting

The project is undergoing MEPA review and requires preparation of a mandatory EIR pursuant to 301 CMR 11.03(6)(a)(7) because it will be undertaken by a State Agency and will construct greater than 1,000 parking spaces in a single location.

The project may require a Sewer Permit Modification from the Boston Water and Sewer Commission (BWSC). The project may be subject to Massachusetts Office of Coastal Zone Management (CZM) federal consistency review. As indicated above, this project is contingent upon MassDEP amending the Logan Airport Parking Freeze to allow the creation of an additional 5,000 commercial parking spaces at the Airport. Should the draft regulations which propose amending the freeze be promulgated as final, MassDEP will submit the final amended Parking Freeze regulations to the U.S. Environmental Protection Agency (EPA) for approval and incorporation into the SIP.

The project may require approval by the Federal Aviation Administration (FAA), which would trigger review under the National Environmental Policy Act (NEPA).[1] The project also requires a National Pollutant Discharge Elimination System (NPDES) General Permit for Construction from the EPA.

Because the project will be undertaken by a State Agency, MEPA jurisdiction is broad in scope and extends to all aspects of the project that may cause Damage to the Environment, as defined in the MEPA regulations.

[1] The ENF indicates that the level of NEPA review, if required, will depend on the chosen alternative and will be at the discretion of the FAA.

Review of the ENF

The ENF includes a general description of proposed activities, a conceptual discussion of proposed conditions, a brief analysis of alternative locations, and an executive summary of the project in English and in Spanish. The ENF provides a suggested scope for the DEIR that identifies further analysis and data that will be provided to assess potential impacts and measures to avoid, minimize, and mitigate these impacts. The ENF does not provide project plans nor a description of the parking structures and notes that design of the structures is pending MassDEP amending the Parking Freeze. I expect that the DEIR will be a comprehensive and thorough filing that includes project plans for the Preferred Alternative and demonstrates that impacts have been avoided, minimized, and mitigated to the maximum extent feasible. C.1

Comments

MassDEP comments indicate that the draft Parking Freeze Amendment is under review and public comment is ongoing. Their comments identify design recommendations for the parking structures (including installation of electric vehicle (EV) charging stations and designation of preferred parking spaces for alternative fuel vehicles) request Massport implement measures to increase HOV and transit travel modes to the airport, including those identified by Massport in the ENF and providing incentives to increase HOV use.

Comments from industry and labor groups support the project and identify the economic support that the Airport provides to the region, including jobs, tax revenue, and financing for business growth. Other comments emphasize the importance of Massport implementing additional measures to reduce reliance on single occupancy vehicles (SOV), including those identified by Massport in the ENF. In addition, comments request Massport consider: implementing a toll for vehicles entering or exiting the airport to be used for HOV improvement measures, improving silver line (SL1) service (in addition to adding new vehicles), and improving the shuttle connection between the Blue Line and the terminals. The Scope for the DEIR requires additional information regarding project mitigation measures and methods to sustain and increase HOV mode share. C.2

Alternatives Analysis

The ENF indicates that the planning process considered six alternative on-airport locations for the structured parking facilities. All of the sites are paved and developed areas that are currently used for parking or vehicle storage. The ENF indicates that each of the sites are comparable in terms of regional VMT and emissions reductions since regional access routes will not vary as a result of the garage siting.

- Harborside Drive – Structured parking in location of existing vehicle layover space
- Porter Street – Structured parking over existing taxi pool
- North Cargo Area – Expand Economy Garage in the location of existing surface parking and the Massachusetts State Police building
- Southwest Service Area – Structured parking in location of current bus/limousine pool and overflow parking

- Economy Garage (Preferred Alternative) – Additional spaces above existing garage
- Terminal E Surface Lot (Preferred Alternative) – Structured parking in location of existing surface parking lot

According to the ENF, the Preferred Alternative was selected based on input from the East Boston Logan Impact Advisory Group (LIAG). The ENF indicates that Harborside Drive and Porter Street sites were eliminated due to potential wayfinding and operational challenges and the North Cargo Area was eliminated due to the need to relocate the existing uses. The Southwest Service Area was eliminated as it would require construction of a new parking structure and integration of existing uses into the ground floor. The ENF indicates that the No-Build alternative was eliminated as it would result in higher pollutant emissions and roadway congestion due to the higher VMT associated with the drop-off/pick-up mode. The ENF identifies the Economy Garage and Terminal E Surface Lots as the Preferred Alternative. The ENF indicates the Economy Garage location was selected as the Preferred Alternative because the site access is well defined, it does not require significant changes to existing roadway infrastructure, and it is adjacent to compatible land uses and the Terminal E Surface Lot location was selected due to its proximity to Airport terminals, compatibility with adjacent land uses, and location within the Airport interior to minimize impacts to adjacent communities.

Air Quality

The project is anticipated to shift mode share from drop-off/pick-up modes and result in reductions in regional off-Airport VMT compared to the future No-Build scenario. The project will result in CO_2, VOC, and NO_x reductions of 25.8%, 25.5% and 25.6% (respectively) in 2022 and 20.2%, 20.0%, and 20.2% (respectively) in 2030 as compared to the future No-Build scenario.

The analysis assumes that HOV modes can accommodate the proportional growth in passenger levels. The ENF indicates that Massport will continue to strive to maintain the current HOV mode share levels, and expand overall HOV capacity as total passenger trips increase.

The ENF indicates that an updated air quality analysis will be provided in the DEIR.

GHG Emissions and Sustainability

The project is subject to review under the May 5, 2010 MEPA Greenhouse Gas Emissions Policy and Protocol ("the Policy"). The ENF indicates that Massport will quantify stationary and mobile source emissions (passenger vehicles) generated by the project. Massport has indicated that stationary source emissions will only be evaluated if the garage contains conditioned spaces. I refer Massport to DOER's comment letter which identifies a limited number of GHG measures that should be evaluated regardless of whether the garages include conditioned space.

The ENF identified Massport's efforts to maintain and increase HOV modes, including strategies related to pricing (incentives and disincentives), service availability, service quality, marketing, and traveler information. The ENF indicates that the parking garages may be

designed to be certified in the new "Parksmart" program, which applies LEED sustainability strategies to structured parking facilities.

Noise

The ENF indicates that ground noise impacts will not change significantly as the project will not require proposed relocation of or changes to existing land use. The ENF indicates that the proposed vertical addition to the Economy Garage may act as an additional noise barrier to the adjacent neighborhood.

Construction Period Impacts

The ENF indicates that construction period impacts and associated mitigation measures, including noise, air quality, traffic, solid and hazardous waste, and water quality will be evaluated in the DEIR. It will also describe project phasing and sequencing. Massport participates in MassDEP's Clean Construction Equipment Initiative and requires engine retrofits to reduce exposure to diesel exhaust fumes and particulate emissions. The ENF indicates that construction activities will comply with MassDEP Solid Waste and Air Quality control regulations.

SCOPE

General

The ENF included a proposed scope for the DEIR. It includes an executive summary, project description, alternatives analysis, planning and sustainable design, traffic and multi-modal transportation, air quality and GHG, and construction impacts. In addition to the Scope items proposed in the ENF, the Scope for the DEIR should be supplemented by the additions and modifications identified below.

Project Description and Permitting

The DEIR should include site plans for existing and post-development conditions at a legible scale including the proposed garage structures and any curbside improvements and changes to the on-airport roadways. (C.3) The DEIR should provide additional information to address construction sequencing and phasing. (C.4) The DEIR should address traffic volumes and crash rates at the Airport. (C.5) It should include a description of existing and proposed conditions, including on and off-Airport access, on-Airport circulation, and parking. The project description should address pedestrian and transit connections between the garages and the airport; pedestrian, transit, and vehicular access and egress locations; access and revenue control systems; anticipated rate structures; and identify hybrid, alternative fuel, and EV parking locations. (C.6) As requested by MassDEP, it should include an evaluation of incorporating EV charging stations into the parking garages and identify the number and location of proposed stations. It should (C.7)

include a discussion of how the construction and design of the garage could facilitate future expansion of EV charging stations if warranted by demand. (C.7 Cont.)

As indicated above, the draft amended Parking Freeze regulations would require Massport to complete three studies to identify ways to further support alternative transit options to the Airport. The results of these studies can be used to inform and benefit the development of mitigation measures for the Logan Airport Parking Project. The DEIR should clarify the timeframe for completed studies relative to the timeframe for developing specific mitigation measures for the Logan Airport Parking Project which are identified in the ENF. It should identify any commitments that would be contingent on the completion of a study. (C.8)

The DEIR should address ground access considerations associated with the parking structures. (C.9) It should describe site and design constraints for both locations. It should identify how the Terminal E garage will be designed consistent with the curbside improvements and changes to on-airport runways associated with the Terminal E Modernization Project which will commence construction in 2018. (C.10) The DEIR should identify and describe any changes to the project since the filing of the ENF and provide an update on permitting. It should include a discussion of permitting requirements and document the project's consistency with regulatory standards, as appropriate. (C.11)

Alternatives Analysis

The DEIR should expand on the initial alternatives analysis and summarize the findings of and the input provided by the community process that guided site selection. The DEIR should identify the number of parking spaces that could be accommodated at each of the alternative locations and describe in more detail why the Southwest Service Area location was eliminated from consideration. (C.12) The DEIR should evaluate potential construction phasing and configurations. (C.13) It should compare and contrast benefits and potential impacts of alternatives in narrative form and in a tabular format. (C.14) The ENF indicates that the project will provide sufficient parking to accommodate approximately five years of peak-day parking demand if growth trends continue at current rates. The DEIR should identify the planning metrics and analysis used to determine the final number of proposed parking spaces (5,000 spaces). (C.15)

Air Quality

As indicated above, the project is anticipated to shift mode share from drop-off/pick-up modes and result in reductions in regional off-Airport VMT compared to the future No-Build scenario. The project will result in CO_2, VOC, and NO_x reductions of 25.8%, 25.5% and 25.6% (respectively) in 2022 and 20.2%, 20.0%, and 20.2% (respectively) in 2030 as compared to the future No-Build scenario. As noted in the ENF, although there has been a long-term trend of decreasing emissions since 1990, airport-wide emissions of VOCs and NO_x are predicted to increase slightly from 2010 to 2030. The ENF indicates that a portion of this increase may be attributed to anticipated increases in air passenger activity levels and associated rise in regional and on-Airport VMT.

The air quality analysis provided in the ENF is predicated on maintaining an approximately 30% HOV mode share and proportional growth in demand for HOV. The DEIR should demonstrate that the HOV programs and any proposed HOV improvement measures will provide the capacity to meet demand associated with growth. C.16 Massport has made significant investments in programs to maintain and increase HOV modes and has been recognized as one of the top-ranking airports in terms of HOV/transit mode share. I note the 2015 Environmental Data Report (EDR) indicated that Massport's current ground access goal is to attain a 35.2% HOV mode share when annual air passenger levels reach 37.5 million. The ENF indicates that passenger levels are approaching this level with over 36 million passengers in 2016. To support Massport's investments and extend their benefits, the DEIR should include an evaluation of measures to support HOV use and extend the associated air quality benefits of the program and identify to what extent these measures will contribute towards attaining the future mode share goal.

These additional measures include: increasing the frequency of transit services, expansion of transit services, parking supply, and pricing; and implementation of tolls or charges that can be used to improve HOV measures. C.17 I note improvements to reduce idling time of HOV modes (i.e. Logan Express, Blue Line Airport Shuttle, and SL1 Silver Line) will also provide air quality benefits. I refer Massport to comment letters which recommend additional measures to improve HOV and reduce VMT. I note monitoring and reporting on the progress towards achieving the goals and success of the mitigation program can be addressed in the Long-Term Parking Management Plan and future Environmental Status and Planning Reports (ESPRs) and Environmental Data Reports (EDRs) (EEA#3247/5146). C.18

The DEIR should identify and analyze localized on-Airport, community ground access, and air quality conditions at each of the proposed locations. The updated air quality analysis for existing and future year conditions should evaluate the changes in transportation and air quality emissions. The air quality analysis provided in the ENF should be revised to reflect the proposed construction phasing and timeframe to identify when the air quality benefits associated with reduced VMT will be realized. C.19

GHG Emissions and Sustainability

The DEIR should include an analysis of GHG emissions and mitigation measures in accordance with the standard requirements of the MEPA GHG Policy and Protocol. The analysis should include project-related stationary source emissions (exterior/interior parking structure lighting, ventilation, etc.) and mobile source emissions (passenger vehicles). C.20 The DEIR should present an evaluation of mitigation measures as outlined in the comments from the Department of Energy Resources (DOER) as appropriate based on whether the parking structures will contain conditioned spaces. C.21 I note that DOER's comments also identify mitigation measures that should be explored absent conditioned space, including but not limited to reduced lighting power densities (LPD) for interior and exterior lighting, parking structure ventilation, and solar photovoltaic (PV) installations. At a minimum, I expect the DEIR will present an evaluation of the feasibility and impact of these measures. This evaluation can be performed as separate calculations in lieu of energy modeling. C.22

9

The DEIR should include an evaluation of rooftop or carport solar PV. It should include a cost analysis to determine the financial feasibility of solar (including potential payback periods) and propose an installation that can be supported by the maximum available roof area (excluding areas dedicated for mechanical equipment) on both parking structures. The DEIR should include the assumed panel efficiency, estimate the electrical output of the system, and estimate annual GHG reductions due to the use of renewable energy instead of electricity or natural gas. The analysis should include a narrative and data to support the Proponent's adoption (or dismissal) of solar PV systems. C.23

The GHG analysis should include an evaluation of the potential GHG emissions of the project's mobile emissions sources using the EPA MOVES emissions model. The DEIR should use data gathered as part of the air quality analysis to determine mobile emissions for Existing Conditions, and the future No-Build, Build, and Build with Mitigation Conditions. The Build with Mitigation Conditions should incorporate measures and associated reductions identified in the Air Quality section above that will support HOV use and extend the associated air quality benefits of the program. C.24

The DEIR should provide emission tables that compare base case emissions in tons per year (tpy) with the Preferred Alternative showing the anticipated reduction in tpy and percentage by emissions source (direct, indirect and transportation). C.25 If the garages include conditioned space, information should be provided for each building in a format similar to the example table provided in DOER's comment letter. C.26

The project is in the conceptual design stage and, as such, provides meaningful opportunities for incorporation of sustainability measures. The DEIR should describe the project's consistency with Massport's Floodproofing Design Guide to demonstrate that the project will incorporate measures into the structure and site design to address potential impacts related to predicted sea level rise. C.27

Noise

The ENF indicates that constructing additional levels on the Economy Garage can serve as an additional noise barrier to the adjacent neighborhood. The DEIR should identify how the sound barrier benefits of the taller garage have been maximized through its design. This evaluation should account for the expanded Terminal E building. C.28

Construction Period Impacts

The DEIR should identify construction period impacts, including noise, air quality, traffic, solid and hazardous waste, and water quality, and identify avoidance, minimization, and mitigation measures. C.29 The DEIR should describe the project phasing and sequencing and address how construction will occur to avoid impacting the existing constrained parking supply. C.30 It should address construction phasing and whether construction will occur simultaneously with the Terminal E project. C.31

10

Mitigation and Draft Section 61 Findings

The DEIR should include a separate chapter summarizing proposed mitigation measures. This chapter should also include draft Section 61 Findings for each area of impact associated with Massport's Preferred Alternative. The DEIR should contain clear commitments to implement these mitigation measures, estimate the individual costs of each proposed measure, identify the parties responsible for implementation (either funding design and construction or performing actual construction), and a schedule for implementation. To ensure that all GHG emissions reduction measures adopted by the Proponent in the Preferred Alternative are actually constructed or performed by the Proponent, I require Proponents to provide a self-certification to the MEPA Office indicating that all of the required mitigation measures, or their equivalent, have been completed. The commitment to provide this self-certification in the manner outlined above should be incorporated into the draft Section 61 Findings included in the DEIR. C.32 C.33 C.34

Response to Comments

The DEIR should contain a copy of this Certificate and a copy of each comment letter received on the ENF. In order to ensure that the issues raised by commenters are addressed, the DEIR should include direct responses to these comments to the extent that they are within MEPA jurisdiction. This directive is not intended, and shall not be construed, to enlarge the scope of the EIR beyond what has been expressly identified in this Certificate. The response can refer to future EDRs and/or ESPRs to address issues that are not within the DEIR Scope. I recommend that Massport employ an indexed response to comments format, supplemented as appropriate with direct narrative response. C.35 C.36 C.37

Circulation

In accordance with Section 11.16 of the MEPA Regulations and as modified by this Certificate, Massport should circulate a hard copy of the DEIR to each State and City Agency from which the Proponent will seek permits. Massport must circulate a copy of the DEIR to all other parties that submitted individual written comments. Per 301 CMR 11.16(5), the Proponent may circulate copies of the DEIR to these other parties in CD-ROM format or by directing commenters to a project website address. However, Massport should make available a reasonable number of hard copies to accommodate those without convenient access to a computer and distribute these upon request on a first-come, first-served basis. Massport should send correspondence accompanying the CD-ROM or website address indicating that hard copies are available upon request, noting relevant comment deadlines, and appropriate addresses for submission of comments. A CD-ROM copy of the filing should also be provided to the MEPA Office. A copy of the EIR should be made available for review at the following Libraries: Boston Public Library – Main, Orient Heights, and East Boson Branches, Chelsea Public Library, Winthrop Public Library, and Revere Public Library. C.38 C.39 C.40 C.41 C.42

May 5, 2017
Date

Matthew A. Beaton

Comments received:

4/13/2017	Matthew Barison
4/14/2017	Massachusetts Competitive Partnership (MACP)
4/21/2017	Associated Industries of MA (AIM)
4/18/2017	South Shore Chamber of Commerce
4/21/2017	Association of Independent Colleges and Universities in Massachusetts (AICUM)
4/24/2017	Bill Schmidt, Vice Chairman, Winthrop Board of Health
4/21/2017	Boston Water and Sewer Commission (BWSC)
4/20/2017	Local 22 Construction & General Laborers' Union
4/25/2017	Patricia J. D'Amore
4/25/2017	John Vitagliano
4/25/2017	Frederick Salvucci
4/25/2017	Metropolitan Area Planning Council (MAPC)
4/25/2017	Massachusetts High Technology Council (MAHT)
4/25/2017	Wig Zamore (1 of 4)
4/25/2017	Wig Zamore (2 of 4)
4/25/2017	Wig Zamore (3 of 4)
4/25/2017	Wig Zamore (4 of 4)
4/27/2017	Boston Financial Services Leadership Council
4/27/2017	Department of Energy Resources (DOER)
5/5/2017	Massachusetts Department of Environmental Protection (MassDEP)

MAB/PRC/prc

B

Comment Letters and Responses

- The twelve comment letters received by the Massachusetts Environmental Policy Act (MEPA) Office on the *2016 Environmental Data Report (EDR)* are reprinted here in the order shown below. As requested in the Secretary of the Executive Office of Energy and Environmental Affairs' Certificate, Massport has provided responses to substantive comments raised in the following letters:

  - Massachusetts Department of Energy Resources (DOER)
  - Town of Milton Board of Selectman
  - Astrid Weins, MD, Ph.D., Winthrop Board of Health
  - Dawn Quirk and Julia Wallerce, Winthrop Airport Hazards Committee
  - Peter Houk, Medford Representative – Massport Community Advisory Committee (CAC)
  - Gail Miller, President – Airport Impact Relief, Inc.
  - John Walkey – GreenRoots
  - Gillian Anderson, East Boston Resident
  - Cindy L. Christiansen, Ph.D., Milton Resident
  - James J. Morgan, Quincy Resident
  - Luke Preisner, Medford Resident
  - Nancy S. Timmerman, P.E., Consultant in Acoustics and Noise Control

This Page Intentionally Left Blank.

COMMONWEALTH OF MASSACHUSETTS
EXECUTIVE OFFICE OF
ENERGY AND ENVIRONMENTAL AFFAIRS
DEPARTMENT OF ENERGY RESOURCES
100 CAMBRIDGE ST., SUITE 1020
BOSTON, MA 02114
Telephone: 617-626-7300
Facsimile: 617-727-0030

Charles D. Baker
Governor

Karyn E. Polito
Lt. Governor

Matthew A. Beaton
Secretary

Judith F. Judson
Commissioner

3 August 2018

Matthew Beaton, Secretary
Executive Office of Energy & Environmental Affairs
100 Cambridge Street
Boston, Massachusetts 02114
Attn: MEPA Unit

RE: Boston-Logan International Airport, Environmental Data Report (EDR), EEA #3247

Cc: Maggie McCarey, Director of Efficiency Programs, Department of Energy Resources
Judith Judson, Commissioner, Department of Energy Resources

Dear Secretary Beaton:

We've reviewed the Environmental Data Report (EDR) for 2016 (published May 2018) for Boston Logan International Airport. EDRs are produced annually to provide a comprehensive review of environmental conditions and impacts associated with the airport.

Logan was responsive to the DOER's request to incorporate emissions and energy data normalized by passenger use and building area. Accordingly, this EDR includes the following:

a. GHG emissions (buildings and transportation) by passenger (lbs CO2 per passenger)
b. GHG emissions (buildings only) by square foot (lbs CO2/sf-yr)
c. Energy use (buildings only) by square foot (kBtu/sf-yr)

Ten years of data was provided for each of the above.

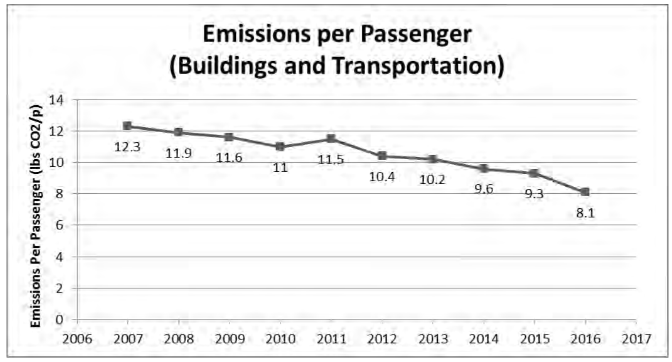
Item (a) above includes most emissions associated with the airport (e.g. plane landing and take-off emissions; Logan support vehicle emissions; all building emissions). Both (b) and (c) include only emissions and energy-use associated with building use. (See EDR for detailed description of emission reporting methods.)

Trends (provided on the following page) show the following:

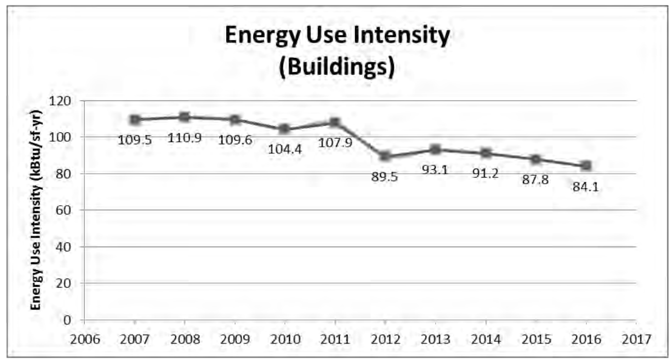
Boston Logan International Airport, EEA #3247
Boston, Massachusetts

1. Logan has successfully reduced emissions per passenger across its operations by 34% in the last decade.

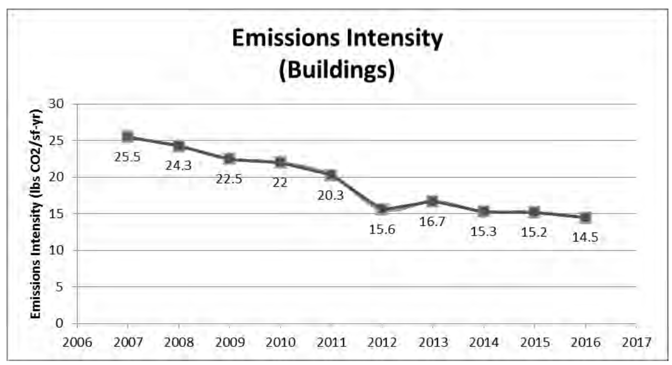
   In 2007, per passenger emissions was 12.3 lbs/passenger. This was reduced to 8.1 lbs/passenger by 2016 according to the data. This decrease in buildings and transportation emissions appears to be maintaining a downward trend.



2. Building energy use intensity and emissions intensity has also been reduced. In the last 10 years, building energy intensity has been reduced 23% while building emissions intensity has been reduced 43%.



We appreciate Logan adding building energy use intensity to the EDR and recommend the following for future EDRs:



a. Ensure that only conditioned (heated and cooled, enclosed buildings) building areas are included in energy use and emission intensity calculations.

b. Report input energy components (oil, gas, electricity) and central plant data.

c. Clarify how renewables (solar PV) are accounted.

The above will help trend progress and asses how resources can be best applied toward emission reduction.

Sincerely,

Paul F. Ormond, P.E.
Energy Efficiency Engineer
Massachusetts Department of Energy Resources

Page 2 of 2

Comment #	Author	Topic	Comment	Response
1-1	Massachusetts Department of Energy Resources	Energy Usage / Emissions	We appreciate Logan adding building energy use intensity to the EDR and recommend the following for future EDRs: a) Ensure that only conditioned (heated and cooled, enclosed buildings) building areas are included in energy use and emission intensity calculations.	The *2017 Environmental Status and Planning Report (ESPR)* greenhouse gas (GHG) assessment characterizes emissions by source, category, and scope in Chapter 7, *Air Quality/Emissions Reduction*. It also includes energy use intensity, similar to what was provided in the *2016 Environmental Data Report (EDR)*. Only conditioned (heated and cooled), enclosed building areas are included in the building energy use intensity and building GHG emission graphs.
1-2	Massachusetts Department of Energy Resources	Energy Usage / Emissions	We appreciate Logan adding building energy use intensity to the EDR and recommend the following for future EDRs: b) Report input energy components (oil, gas, electricity) and central plant data.	Massport has added two graphs to Chapter 7, *Air Quality/Emissions Reduction* showing building energy sources and building GHG emission sources. Building energy sources include electricity (55 percent), natural gas (44 percent), and fuel oil (1 percent). Building GHG emission sources include electricity (69 percent), natural gas (30 percent), and fuel oil (1 percent).
1-3	Massachusetts Department of Energy Resources	Energy Usage / Emissions	We appreciate Logan adding building energy use intensity to the EDR and recommend the following for future EDRs: c) Clarify how renewables (solar PV) are accounted.	Building electricity (and therefore energy total) has accounted for renewables by taking credit for avoided GHGs for that portion of energy. Therefore, total energy includes some energy that is generated by renewables (with the exception of those that are under Power Purchase Agreements [PPAs]), but the energy total used to calculate GHGs excludes Renewable Energy Credit (REC) purchases and non-PPA on-site renewable generation.

This Page Intentionally Left Blank.

COMMONWEALTH OF MASSACHUSETTS
TOWN OF MILTON
OFFICE OF SELECTMEN
525 CANTON AVENUE, MILTON, MA 02186
TEL. 617-898-4843
FAX 617-698-6741

MICHAEL D. DENNEHY
TOWN ADMINISTRATOR

SELECTMEN
RICHARD G. WELLS JR.
CHAIRMAN
MICHAEL F. ZULLAS
VICE CHAIR
MELINDA COLLINS
SECRETARY
KATHLEEN M. CONLON
MEMBER
ANTHONY J. FARRINGTON
MEMBER

RECEIVED
JUL 27 2018
MEPA

The Honorable Matthew Beaton, Secretary
Executive Office of Energy and Environmental Affairs
Attn: Massachusetts Environmental Policy Act ("MEPA") Office
EEA No. 3247
100 Cambridge Street, Suite 900
Boston, MA 02114

July 23, 2018

Re: Comments of the Town of Milton on the Boston-Logan International Airport 2016 Environmental Data Report (2016 EDR)

Dear Secretary Beaton,

The Board of Selectmen of the Town of Milton ("Milton") is pleased to provide the following comments[1] in response to the Boston-Logan International Airport 2016 Environmental Data Report ("2016 EDR"):

1. Overall Themes of the 2016 EDR

The 2016 EDR and prior EDRs begin with a discussion of the economic contributions Logan International Airport makes to the Boston, the Massachusetts, and the New England economies.[2] While Milton acknowledges and appreciates these contributions, we believe the 2016 Environmental Data Report should begin and end with the important *environmental* impacts of

[1] In Milton's comments on the 2014 and 2015 EDRs, we provided some background on the demographics of Milton, which we repeat here for context. Milton is a predominantly residential community with a population of 27,000, which is racially diverse (71% white, 20% African American). Comprised of only 13.3 square miles, Milton bears a significant burden of heavy air traffic arriving and departing Boston-Logan International Airport through three (3) RNAVs (designated as 4R, 27, and 33L), with two more RNAVs recently proposed by the FAA and undergoing environmental review (4L visual and 4L instrument). Because Milton is mostly comprised of single-family homes with backyards, people often choose to live in Milton to raise their families. Thus, the tremendous amount of aircraft noise imposed on the town severely diminishes the quality and standard of living, as residents report severe sleep deprivation and other impacts, such that they are unable to enjoy either their homes and properties, or Milton's recreational areas and open spaces, particularly during periods of unbroken and intensive use of the 4s.

[2] However, we note that while passenger volumes have increased, many of these passengers never leave the airport grounds. Boston is a significant hub for national and international travel, not necessarily a destination. This is an important distinction that is lacking in the discussion of the economic import of the airport.

the presence of the airport on all its surrounding communities and residents, i.e., the "Boston catchment" communities, to utilize the language of the 2016 EDR. We do not believe enough emphasis is placed on the impacts to the communities outside the immediate boundaries of the airport.[3]

Milton was also surprised that Massport's 2016 environmental publication was an EDR as opposed to the planned Environmental Status and Planning Report (ESPR). The rationale for this change is that the "passenger demands for air travel have been rapidly increasing, and the air carrier landscape is changing." Massport further states that "2016 does not serve as a reasonable baseline for prediction of long-range impact assessment." EDR p. 1-1. While we agree that the landscape is changing rapidly, we are frustrated because Milton has repeatedly made this point to Massport in our comments on the 2014 and 2015 EDRs and in our comments on the Terminal E Expansion project. We believe Massport has downplayed the speed and intensity of these changes over the last several years, and we emphasize the necessity of considering the impact these changes have on both airport operations and on the residents impacted by airport operations throughout the Boston catchment area.

Finally, we disagree with Massport's statement, featured in the second paragraph of the Introduction/Executive Summary that "[o]ver the long-term, environmental impacts associated with Logan Airport have been decreasing." EDR p. 1-1. Neither the data presented in the 2016 EDR, nor the experiences of the resident of the Town of Milton, and residents of many other surrounding communities impacted by airport operations, supports this statement. As in the 2015 EDR, Massport continues to refuse take into account the increased number of complaints from Milton and other surrounding communities that are overflown by certain RNAVs. The fact that disruption caused by Logan Airport is growing should be acknowledged within the 2016 EDR and Massport should have a plan to provide relief from this disruption to the affected communities. To date, after almost four years of attempting to get Massport's attention on this issue, and despite participation in the LCAC and the MCAC, there has been no substantive progress by Massport that provides relief to the impacted Milton residents or the residents of other communities.

2. Increased Noise Complaints Reported

Table 6-16 demonstrates that no single community makes as many complaints on the Noise Complaint Line as Milton, and both the number of complaints and the number of callers has increased. In Milton, the number of complaints increased from 4,991 reported in the 2015 EDR to 21,796 reported in the 2016 EDR – a more than a 4-fold increase in the number of complaints filed. The number of callers similarly increased from 343 to 466, a 35% increase in the number of callers. Complaints on the Massport complaint line from Milton have increased from an average of 9 per month in 2012, to an average of 416 per month in 2014, to an average of 1816 per month in 2016. That represents a *200-fold increase in total noise complaints in the last 6 years*.

[3] For example, in the Introduction/Executive Summary, noise impacts are not discussed until page 28, and air pollution is not discussed until page 34.

As the report indicates, "noise annoyance is growing among a concentrated population." Milton is one of those concentrated populations where noise annoyance -- which includes lack of sleep, disrupted and interrupted sleep, interrupted conversation, and impacts on use of outside spaces such as decks and yards – is growing. This noise annoyance is not simple NIMBYism, or the complaints of a few people, as Massport seems to imply. These are real impacts, suffered by real people, who live in nearby communities. It is outrageous that Massport still has no plan in place to address impacts on these citizens. We request that the Secretary direct Massport and the MCAC to immediately prepare a plan to address and mitigate the noise impacts from RNAVs within Milton, and to share it with Milton.

3. Faster than Expected Growth in Airport Operations at Logan

In our 2015 EDR comments concerning Massport statements about aircraft activity compared to 2000, Milton stated: "*We submit that comparison [with 2000] is no longer valid, as airlines have significantly changed their modes of operation in the intervening 15 years, by relying on progressively larger airplanes, with progressively larger, more powerful, and louder jet engines. Further, the implementation of the FAA's RNAV systems has also changed how aircraft arrive and depart over surrounding communities.*" We note that Massport continues to utilize this inaccurate and misleading data point for comparison purposes, which has the impact of downplaying the significant increase in airport operations at Logan over the past 5-10 years, particularly since the implementation of the RNAVs.

As reported by Massport, the 2016 Logan catchment area is growing faster than the Boston metropolitan area and New England generally. This increased pressure on Logan is reflected in the increased flights and increased noise complaints. As stated in the Executive Summary: the role of Logan Airport is expected to continue its dominance since the population of the catchment area has grown faster (0.9 percent) than the population of the United States (0.8 percent), Massachusetts (0.6 percent), and New England (0.4 percent) since 2010 (see Table 1-1). The catchment area population is projected to increase at an average rate of 0.5 percent each year over the next 19 years (see Figure 1-4)." 2016 EDR p. 1-7

According to the 2016 EDR, in 2016, U.S. passenger traffic grew by **3.8 percent**, whereas Logan Airport experienced a passenger growth of **8.5 percent**, more than double during the same period. Overall, Logan Airport served 55 non-stop international destinations in 2016, compared to 47 in 2015. From 2000 to 2016, the annual number of passengers at Logan Airport increased by 30.9 percent, while the annual number of aircraft operations decreased by 19.8 percent (see Figure 1-9). The total number of air passengers increased by 8.5 percent to 36.3 million in 2016, compared to 33.4 million in 2015 (see Figure 1-10). The 2016 passenger level represents a new record high for Logan Airport.

We are not surprised by this rapid growth, only that Massport has continued to downplay its impact on overall airport operations and overall impacts of airport operations on the surrounding communities. As we noted in our comments on the 2015 EDR:

We think it unlikely this demand will cease in the near future. We note that the entire New England region has a record high in passenger traffic (however that is defined). The impacts to Milton and other communities will only increase. While we understand and support Logan's role in the economic development of New England, we believe that development cannot come at the price of the right of citizens to peacefully co-exist within their homes. There needs to be a better balance, such that the economic success of the region, and of Logan and Massport, is not based on continuing impacts to its neighbors. Massport and the airline community have a duty and responsibility to protect the neighbors and communities underneath the publically owned airspace through which they travel.

Unless and until this situation is rectified, and Massport either provides a community by community analysis, or the RNAVs and overflights are distributed more fairly, the EDRs will continue to provide an inaccurate accounting of the real impacts of Logan operations on Milton and other communities.

4. Increased Nighttime Operations

As in the 2014 and 2015 EDRs, the 2016 EDR acknowledges that nighttime operations at Logan – defined as from 10:00 P.M. to 7:00 A.M. – continues to increase. Total use during nighttime hours increased again, by almost 13% in 2016 compared to 2015, and has increased by over 20% since 2010 (Table 6-3).

Although the noise complaint data is not broken down by time of day (either when the complaint was filed, or that the complaint concerned nighttime operations), it follows that some portion of the increase in complaints in Milton is driven by increased nighttime operations. Data continues to be developed which indicates airplane noise in overflown communities disrupts sleep patterns, which has been shown to result in adverse human health impacts.

Anecdotal data from Milton residents indicate that the noise from airplanes in Milton is clearly heard above background noise in both commercial and residential areas. As elected officials, we hear frequently from Milton residents who suffer from interrupted sleep, anxiety, and a reduced quality of life because of the noise pollution caused by very frequent – and some days continuous – flights over Milton at low altitudes. These impacts are exacerbated by the increasing volume of late night and early morning RNAV-based traffic. We cannot overstate the seriousness of the health problems that these RNAVs cumulatively pose for Milton residents, and the adverse cumulative environmental impact that the RNAVs and the low flying planes have on our entire community.

The FAA has recently reported to the MCAC that a refinement of the curved nighttime approach to 33L is likely to result in increased use during the hours of 12AM to 6AM. Massport reports that typically, there are 55 arrival operations between 11PM and 6AM, 20 between 11PM and 12AM, and 12 between 5AM and 6AM. We took a count of arrivals to Logan on Tuesday June 19th to 20, 2018 between the hours of 11PM and 5AM, and counted 80 arrivals (45 % more arrivals than reported by Massport), as follows:

11PM – 26 arrivals
12AM – 27 arrivals
1AM – 4 arrivals
2AM – 5 arrivals
3AM – 1 arrival
4AM – 2 arrivals
5AM – 15 arrivals

Additional nighttime operations are simply not sustainable because of the significant health impacts on the overflown populations. We request that the Secretary work with Massport, the MCAC, and Milton to implement additional late night aircraft restrictions, similar to those set forth in 740 CMR 24.04, which are more protective of Milton and its residents. In particular, it is important to discuss restrictions on RNAV usage and routes that overfly residential neighborhoods, including spreading the routes further so that the nighttime noise is less concentrated in residential neighborhoods, or moving routes over the ocean during certain periods of time. Specifically, as there are already nighttime restrictions on arrivals to runway 22 and departures for runway 4L, we request similar restrictions (no arrivals between 11:00 PM and 6:00 AM) for on runway 4R. See Massachusetts Port Authority ("Massport") Noise Rules and Regulations I.1(b), Summary of Runway Use Restrictions, Boston Logan International Airport (May 2, 2016) (also referenced in FAA BOS ATCT Noise Abatement Order 7040.1H).

5. Logan Community Advisory Committee ("LCAC") and Abandonment of the PRAS Goals

Ultimately, Milton seeks fairness and equity in the distribution of airplane operations and the impacts of those operations. It is undisputed that Milton receives a disproportionate impact of airplane operations in the Boston-Logan area. The skies over Milton are already saturated with airplanes, often from very early morning until very late at night. Implementation of two new RNAVs over Milton (4L visual and 4L instrument), plus the increasing volume of airplane activities at Logan, will increase the existing inequity.

We are very disappointed that the FAA, with Massport's concurrence, has discontinued funding the LCAC, and appears to have abandoned developing a replacement for the PRAS goals as required by the 2002 Record of Decision ("ROD"). The Preferential Runway Advisory System ("PRAS") was established "to provide an **equitable distribution** of Logan Airport's noise impacts on surrounding communities." The two primary objectives of the PRAS goals are: (1) to distribute noise on an annual basis; and (2) to provide short-term relief from continuous operations over the same neighborhoods at the ends of the runways. 2016 EDR, page 6-27 (emphasis added).

The LCAC voted to abandon the PRAS goals in 2012. However, no other guidelines were put in its place, and Massport still reports runway usage with respect to the PRAS goals (Table 6-5). The PRAS goals offer at least some picture of what a fair distribution of aircraft traffic might look like using one particular tool, i.e., differential runways (being mindful that these PRAS goals were created well before RNAV concentrated flight routes were implemented). Thus, at this stage, only achieving balanced runway usage would not be sufficient to relieve those under

the RNAVs, although it would be a step in the right direction. Ultimately, a fair resolution of these ongoing noise issues in Milton will require further dispersion of the aircraft traffic from the concentrated RNAVs.

We note that while the PRAS goal for arrivals on runways 4R/4L is 21.1%, the 2016 effective usage is reported at 26.4%, an increase over the 25.1% reported for 2015 – despite the fact that Runway 4L was shut down for improvements during a portion of the reporting period. When added to the impacts from the southbound 27 departures (27% of all 27 departures and 3.5% of all jet departures) and southbound 33L departures (15% of all 33L departures and 2.7% of all jet departures), Milton is impacted by much of the daily airline traffic moving in and out of Logan, and in a greater proportion than was initially planned or expected, based on the PRAS goals. In total, Milton received 6.2% of all jet departures in 2016, and 34.8% of all jet arrivals.[4]

Milton continues to be ready to work on these equity issues, either via the MCAC, or directly with Massport and the EEA agencies. We again request that the Secretary direct Massport and the MCAC to promptly develop a system for the fair and equitable distribution of aircraft overflights that provides real relief to the highly impacted surrounding communities

6. Public Health Concerns Related to Airplane Overflights.

Once again, the 2016 EDR only discussed air pollution from airport operations in the context of the actual operations of Logan Airport, on Logan property. We repeat our earlier comments that this perspective is overly narrow. There are much scientific date and studies, which demonstrate that airplane overflights are a well-established public health hazard. A recent consensus paper prepared by the Impacts of Science Group of the Committee for Aviation Environmental Protection of International Civil Aviation Organization summarized the state of the science of noise effects research as related to airplane overflights. Basner, et al, March-April 2017 found impacts including: community annoyance, children's learning, sleep disturbance, and health effects (cardiovascular disease and psychological health). Further, recent studies at LAX (Hudda, et al., May 2014) found ultrafine particle counts as far as ten miles from heavily used arrival runways. A recent Logan-specific study (Hudda, et al., February 2018) presents strong evidence demonstrating the infiltration of Logan-related ultrafine particles into Chelsea homes, during times when winds blow from Logan toward Chelsea homes that were monitored, indoors and outdoors, by a Tufts-based research team with high quality air pollution instruments over extended periods. Ultrafine particles continue to be a global environmental health concern and have been related to cardiovascular risk as well as other serious public health outcomes. It is clear that between the infiltration of ultra-fine particles, and the ongoing noise problems, not even our homes are safe from the impact of Logan Airport and its operations.

We request that the Secretary direct Massport, in conjunction with the Department of Public Health ("DPH") and the Department of Environmental Protection ("DEP"), to conduct noise and air pollution studies in Milton and other communities which receive a substantial number of low-flying arrival aircraft. This work would be consistent with the evolving science on this point, and protective of the residents in these communities. We further request that the scope of the

[4] Milton also receives overflights by prop planes to 4L, 4R, 22L, and 27.

future EDRs (and ESPRs), beginning with the next EDR and ESPR, be expanded to consider the health impacts from increased and concentrated arrival and departure operations due to RNAVs, and that pollution data be measured for every community under any of the many Logan RNAVs.

7. Scope of the 2017 ESPR

First, we believe it is important to consider the off-airport impacts of the growth of Logan itself and the increased passenger throughput and increased aircraft operations at Logan. The increased demand for airport services impacts the surrounding communities by increasing the volume and concentration of overflights, and by increasing the amount of nighttime operations and nighttime overflights. Each of these impacts must be studied – from noise to pollution and more, to have a true assessment of the environmental impacts resulting from operations at Logan. The current approach, which only assesses on-airport pollution is wrong-headed and ineffectual. It ignores the robust science that demonstrates that airport operations can impacts communities as far as 10 miles beyond the airport location, particularly where those communities are overflown by multiple RNAVs and the aircraft traffic is concentrated and persistent.

Second, the scope must include analysis of the cumulative impacts from increasing numbers of RNAVs flown over surrounding communities. As noted, there are three RNAVs that overfly Milton, with two others proposed. Looking at these impacts in isolation does not provide an actual assessment of on-the-ground impacts – some of which are reflected in the increasing number of noise complaints filed in these communities.

Third, we urge Massport and the Secretary to move to a more updated method for noise assessment, and either discontinue using the DNL standard, or reduce the threshold at which noise impacts are considered significant. The DNL standard "masks" the acute impacts a succession of aircraft flying over a home has on the sleeping residents within, and also masks the acute impacts felt in a community when it is overflown for hours on end, with little break in the incoming or departing aircraft.

Finally, we urge Massport and the Secretary to collaborate with the impacted communities, and to work with them directly, rather than just giving lip service to working with them. It is appropriate to acknowledge that multiple communities surrounding Logan (not just Milton) take the brunt of the impact of the operations of Logan. These communities should have direct and regular access to Massport and the Secretary, and both agencies should be willing to work on real and meaningful solutions to address the problems from airport operations – especially noise and pollution -- occurring in those communities. While we understand some of that work must be done via the MCAC, the large size and the organization of the MCAC has the unintentional effect of diluting the voices of the most affected communities.

8. Conclusion and Request for Assistance.

Thank you for your attention to and consideration of our comments on the 2016 EDR. We believe that there are solutions available to remedy and mitigate the ongoing impact of Logan operations on the residents of Milton, and throughout the Logan Airport overflight area. We note that many of these comments have been made before, because despite continued efforts to

work closely with Massport, both directly, and through the MCAC, Milton has yet to receive any relief from the continuing significant annoyance and public health impacts posed by these overflights.[5] Therefore, again, we request that the Secretary work with Massport, Milton, the MCAC, and other effected communities to help remedy the multiple impacts discussed above.[6] Specifically, Milton requests the following actions be taken:

a. Direct Massport to prepare a plan to address and mitigate the noise impacts from the RNAVs overflying Milton, and to share it with Milton, within the next three (3) months;
b. Work with Massport, the MCAC, and Milton to develop and implement additional late night/early morning aircraft overflight restrictions which are more protective of Milton and its residents, including consideration of an 11:00 PM to 6:00 AM landing prohibition on runway 4R;
c. Direct Massport and the MCAC to promptly develop a system for the fair and equitable distribution of aircraft overflights that provides real relief to the highly impacted surrounding communities, especially those that are under multiple RNAVs;
d. Direct Massport to collaborate with DPH and DEP to develop and conduct noise and air pollution studies in highly impacted surrounding communities, especially those that are under multiple RNAVs;
e. Direct Massport to consider off-airport noise and pollution impacts, including but not limited to the health impacts from increased and concentrated arrival and departure operations due to RNAVs, in all communities under any RNAV, in all future EDRs
f. Direct Massport to include all of the points made above in the scope of the 2016 ESPR. This includes impacts to health from noise and pollution from: off-airport impacts of growth, cumulative impacts of RNAV overflights, increased nighttime operations, moving to updated noise measurements which are more protective of human health and which account for acute impacts more realistically than the DNL standard; and working directly with impacted communities to more fully understand and evaluate the human health effects from Logan operations.

We would appreciate a time to meet with you and your staff to personally discuss the concerns we have outlined here, as well as our specific requests for assistance.

[5]On average, 1,816 complaint calls per month indicate that Milton residents are experiencing significant annoyance from the airplane overflights.

[6] We also note that Massport did not sufficiently respond to these specific requests in its response to comments to the 2015 EDR, despite being required to address all comments filed on that document.

Sincerely,

Board of Selectmen of the Town of Milton

Richard G. Wells, Jr., Chair

Kathleen M. Conlon

Kathleen M. Conlon

Melinda A. Collins

Melinda A. Collins

Michael F. Zullas

Anthony J. Farrington

cc: Congressman Stephen F. Lynch
Congressman Michael E. Capuano
U.S. Senator Elizabeth A. Warren
U.S. Senator Edward J. Markey
State Senator Walter F. Timilty
State Representative William Driscoll
State Representative Daniel R. Cullinane
Governor Charlie Baker
Attorney General Maura Healy
Milton Board of Health
Milton Airplane Noise Advisory Committee Chair Andrew Schmidt
MCAC Representative Cindy L. Christiansen
Town Counsel Karis L. North

Environmental Science & Technology

Article

Cite This: Environ. Sci. Technol. XXXX, XXX, XXX−XXX

pubs.acs.org/est

Aviation-Related Impacts on Ultrafine Particle Number Concentrations Outside and Inside Residences near an Airport

N. Hudda,*[†] M.C. Simon,[†,‡] W. Zamore,[§] and J.L. Durant[†]

[†]Department of Civil and Environmental Engineering, Tufts University, 200 College Ave, 204 Anderson Hall, Medford, Massachusetts 02155, United States

[‡]Department of Environmental Health, Boston University, 715 Albany Street, Boston, Massachusetts 02118, United States

[§]Somerville Transportation Equity Partnership, 13 Highland Ave, #3, Somerville, Massachusetts 02143, United States

Supporting Information

ABSTRACT: Jet engine exhaust is a significant source of ultrafine particles and aviation-related emissions can adversely impact air quality over large areas surrounding airports. We investigated outdoor and indoor ultrafine particle number concentrations (PNC) from 16 residences located in two study areas in the greater Boston metropolitan area (MA, USA) for evidence of aviation-related impacts. During winds from the direction of Logan International Airport, that is, impact-sector winds, an increase in outdoor and indoor PNC was clearly evident at all seven residences in the Chelsea study area (~4−5 km from the airport) and three out of nine residences in the Boston study area (~5−6 km from the airport); the median increase during impact-sector winds compared to other winds was 1.7-fold for both outdoor and indoor PNC. Across all residences during impact-sector and other winds, median outdoor PNC were 19 000 and 10 000 particles/cm^3, respectively, and median indoor PNC were 7000 and 4000 particles/cm^3, respectively. Overall, our results indicate that aviation-related outdoor PNC infiltrate indoors and result in significantly higher indoor PNC. Our study provides compelling evidence for the impact of aviation-related emissions on residential exposures. Further investigation is warranted because these impacts are not expected to be unique to Logan airport.

INTRODUCTION

Aircraft engine exhaust emissions are a significant source of ultrafine particles (UFP; aerodynamic diameter <100 nm) and can cause several-fold increases in ground-level particle number concentrations (PNC) over large areas downwind of airports.[1−4] The spatial extent and magnitude of the impact varies depending on factors including wind direction and speed, runway use pattern, and flight activity but encompasses large populations in cities where airports are located close to the urban residential areas. For example, in Amsterdam, PNC (a proxy for UFP) were found to be elevated 7 km downwind of Schiphol Airport[2] while in Los Angeles, PNC were reported to be elevated 18 km downwind of Los Angeles International Airport.[1,3] Thus, it is important to characterize aviation-related UFP.

Previous studies have shown that UFP can cross biological boundaries (entering the circulatory system) due to their extremely small size.[5−7] Exposure to UFP is of particular concern because it is associated with inflammation biomarkers, oxidative stress and cardiovascular disease.[6] Recent exposure assessment studies have started testing airport variables in UFP predictive models,[8−12] but epidemiological studies that incorporate airports in the exposure assessment are lacking; currently, they primarily focus on traffic-related UFP. To better inform UFP exposure assessment efforts, it is also important to distinguish aviation-related contributions from other urban sources and to characterize them independently. This is particularly challenging in urban areas with pervasive and dense road networks. Furthermore, studies have shown that residing in the vicinity of airports is significantly associated with hospitalization for cardiovascular disease;[13,14] however, there the focus has been on association between cardiovascular health effects and increased noise around airports, which can be confounded by UFP. To date, no studies described in the literature investigate the health effects of UFP, or of noise controlling for UFP, around airports.

In a previous study, we found that during winds from the direction of the Logan International Airport (Boston, MA) PNC at two long-term, central monitoring stations located 4 km and 7.5 km downwind of the airport were 2-fold and 1.33-fold higher, respectively, compared to average for all other winds.[4] In the current study, we investigated residential data sets from wider areas surrounding those two central sites. Our primary objectives were (1) to investigate short-term residential PNC monitoring data for evidence of aviation-related impacts that could be identified despite the influence of other urban sources of UFP, and (2) to analyze the data for evidence of indoor infiltration of aviation-related PNC. To our knowledge,

Received: November 1, 2017
Revised: January 5, 2018
Accepted: January 9, 2018

DOI: 10.1021/acs.est.7b05593
Environ. Sci. Technol. XXXX, XXX, XXX−XXX

this is the first study to report the impact of aviation-related emissions inside residences.

■ MATERIALS AND METHODS

Logan International Airport and Central and Residential Monitoring Sites. The General Edward Lawrence Logan International Airport is located 1.6 km east of downtown Boston (Figure 1(a)). It has six runways and supports about 1000 flights per day. Flight statistics are shown in the Supporting Information (SI) Figure S1. Prevailing winds in the Boston region are westerly (northwest in winter and southwest in summer, combined annual frequency 56%, see Figure 1(b)). The downwind advection of airport-related emissions occurs largely over urban areas located east and northeast of the airport as well as over the ocean during prevailing winds. During easterly winds, several other urban areas are downwind of the airport. We studied two of these areas: Chelsea and Boston.

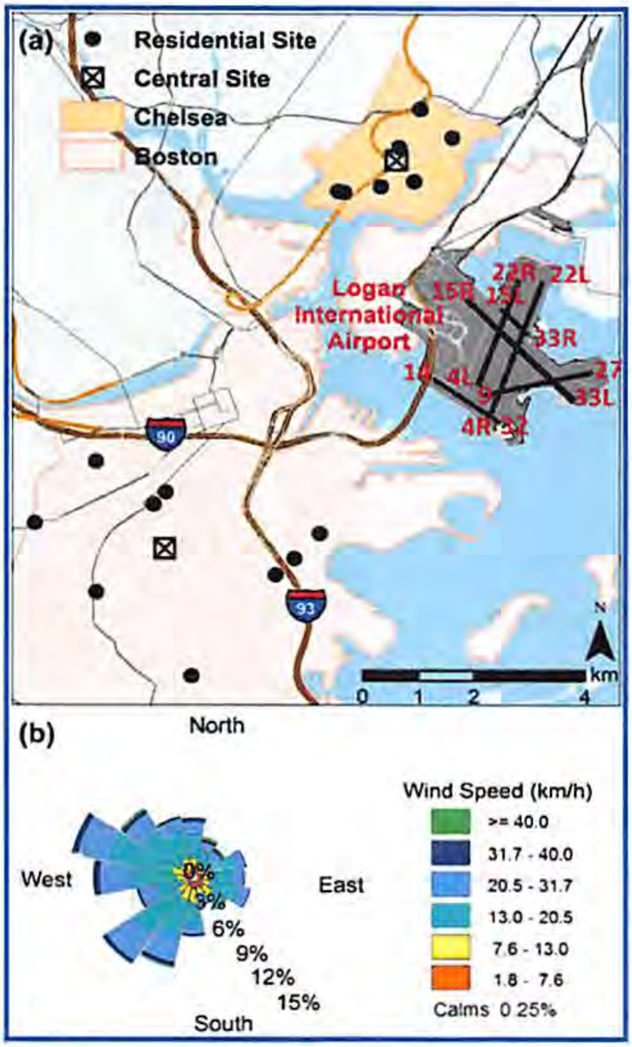


Figure 1. (a) Map of the runways at Logan International Airport and the locations of the central and residential monitoring sites in Chelsea and Boston. Base layers were obtained from mass.gov. (b) Windrose is based on 1 min data for 2014 reported by National Weather Service Automated Surface Station located at the airport.

In Chelsea, outdoor (i.e., ambient) and indoor monitoring was conducted at seven residences that were located 3.7—4.9 km downwind from the airport along 133°—165° azimuth angles measured to the geographic center of the airport (Figure 1(a)). Each residence was monitored for six consecutive weeks between February — December 2014. Ambient monitoring was also conducted continuously at a central site in Chelsea (located on top of a three-story building) during the entire 11-month period (Figure 1(a)). In Boston, monitoring was conducted at nine residences between May 2012 and October 2013. The residences were located 5.0—10.0 km downwind from the airport along 43°—74° azimuth angles measured to the geographic center of the airport. Monitoring was also conducted continuously during this 18-month period at a central site in Boston—the U.S. Environmental Protection Agency Speciation Trends Network site (ID: 25−025−0042). Central sites were selected based on their proximity to the geographic center and representativeness for the study area. Residential sites were selected based on their proximity to highways and major roads (the latter defined as annual average daily traffic >20 000): four sites were <100 m, seven between 100 and 200 m, and five >200 m from highways or major roads. Monitoring schedule, meteorological parameter summary, residence characteristics, and distance to major roadways are shown in SI Tables S1−S6.

During the six-weeks of monitoring at each residence, a HEPA filter (HEPAirX, Air Innovations, Inc., North Syracuse, NY) was operated in the room where the condensation particle counter (CPC) was located for three consecutive weeks followed by three consecutive weeks of sham filtration or vice versa. Only nonsmoking residences were recruited and we found no evidence of smoking in residences. Residences were monitored one or two at a time with limited overlap between monitoring periods. For further details of residential monitoring and filtration, see Simon et al.[15] and Brugge et al.,[16] respectively.

Instruments and Data Acquisition. PNC were monitored using four identical water-based CPCs (model 3783, TSI Inc., Shoreview MN), which recorded 30 s or 1 min average concentrations. The CPCs were annually calibrated at TSI and measured to within ±10% of one another, consistent with manufacturer-stated error. Ambient PNC were monitored continuously at the central-sites. At residences, a solenoid valve connected to the inlet switched the air flow between outdoor and indoor air every 15 min. Thus, residential outdoor and indoor PNC were monitored for 30 min per hour. To ensure that the sampling lines (1-m-long conductive silicon tubing for both indoor and outdoor carrying transport flow of 3 L per minute) were fully flushed, the first and last data points per switch were discarded (7−13% of the total). Any data that were flagged by the instruments (<1% of the total) and hours with <50% data recovery were not included in the analysis.

Flight records for individual aircraft were obtained from the Massachusetts Port Authority (East Boston, MA) and counted to obtain hourly totals for landings, takeoffs and the sum of the two (LTO). Meteorological data (a 2 min running average at 1 min resolution for wind direction and speed) were obtained from the National Weather Service station at the airport and processed through AERMINUTE[17] (a meteorological processor developed by EPA for use in AERMET and AERMOD) to obtain hourly values.

Data and Statistical Analysis. Each PNC data set (residential indoor, residential outdoor, and central-site) was

DOI: 10.1021/acs.est.7b05593
Environ. Sci. Technol. XXXX, XXX, XXX−XXX

Table 1. Impact Sector Definitions and Summary of Particle Number Concentration Statistics for Residential Sites

ID	distance to airport (km)	impact sector definition (WD°)	impact sector winds frequency, hours	impact-sector winds hourly PNC statistics: outdoor median	impact-sector winds hourly PNC statistics: indoor median	impact-sector winds hourly PNC statistics: indoor minimum	other winds hourly PNC statistics: outdoor median	other winds hourly PNC statistics: indoor median	other winds hourly PNC statistics: indoor minimum
				Chelsea Residences					
D1	4.3	111−155	4.7%, 47	36 000	11 100	7600	13 200	4400	3700
D2	4.4	111−154	5%, 50	37 100	14 600	7500	16 200	5100	3500
U1	4.9	142−176	5.3%, 53	14 900	2300	1400	7800	1900	1600
U2	4.0	117−164	11.8%, 119	18 600	2500	1800	10 700	2400	1800
C1	4.2	145−182	5.2%, 50	12 800	3500	2800	8100	2500	1900
C2	4.4	130−171	5.4%, 54	19 700	1900	1300	9700	2200	1700
C3	3.7	124−173	10.8%, 111	26 600	6400	4700	8900	2800	2200
				Boston Residences					
D1	6.1	31−59	6.9%, 63	27 800	8400	4300	10 700	5300	4000
U1	5.0	28−61	8.4%, 79	25 100	22 700	17 500	14 700	7400	6100
U2	5.6	30−59	8.2%, 70	19 700	10 900	6900	9700	6100	3700
C1	6.8	53−79	9.6%, 97	9400	3700	2600	8000	2300	1800
C2	7.1	53−78	3%, 30	11 900	7900	6400	10 000	4100	2800
C3	7.8	62−86	9.6%, 94	21 000	7700	5800	14 300	3900	3300
B1	10.0	33−53	3.4%, 34	13 500	4900	4200	10 100	4500	3400
B2	8.8	48−67	6%, 65	8200	4900	3200	7200	4500	3000
B3	9.2	60−78	4%, 39	12 900	15 400	11 600	8100	6300	5100

aggregated separately to calculate hourly medians. Hourly medians were further aggregated by 10°-wide wind-direction sectors, and medians were calculated for each sector. Wind-direction sectors were centered on even 10° and spanned ±5°. Data were also classified as impact-sector versus other based on the wind direction. Winds that positioned monitoring sites downwind of the airport were called *impact-sector* winds. Impact-sector boundaries (Table 1) correspond to the azimuth angles measured from a monitoring site to the widest distance across the airport complex (SI Figure S2).

For indoor data we also calculated the hourly minimum in addition to hourly medians. Indoor data were also classified by filtration scenario (HEPA or sham). Indoor measurements reflect contributions from both particles generated indoors and particles of outdoor origin that infiltrate indoors. We did not quantify fraction of indoor- versus outdoor-origin particles. Instead, we compared hourly indoor minimums (less likely to be influenced by indoor-generated PNC spikes) with outdoor PNC to determine if higher indoor PNC occurred during impact-sector winds. During periods of elevated outdoor concentrations, indoor concentrations are also expected to be elevated due to air exchange between residences and their surroundings.

Spearman's rank correlation (coefficients reported as r_S) was calculated between PNC and wind speed and PNC and LTO. Inferences based on Spearman's rank correlation were limited to ordinal associations. Correlations were considered significant if p-values were <0.05. Bootstrapped 95% confidence intervals for the correlation coefficients were also calculated. Further, impact-sector wind data sets at residences were relatively small; they ranged from 30 to 119 h or 3.0−11.8% of the total data. To take the resulting uncertainty into account, we compared distributions of correlation coefficient estimates − generated using bootstrap resampling methods (1×10^4 random samples with replacement) − for impact-sector winds to other winds. Subsamples (1×10^4 random samples without replacement) from other-wind data sets but of size comparable to impact-sector-winds were also compared where appropriate.

■ RESULTS AND DISCUSSION

We found strong evidence of aviation-related particle infiltration. Outdoor and indoor PNC were statistically significantly higher during impact-sector winds compared to other winds. Wilcoxon rank sum tests indicated that the median of 10°-wide-sector medians from all residences for impact sector winds was higher than other winds for outdoor concentrations (p-value <0.0001, z-value = −8.1) as well as for indoor concentrations during both sham filtration (p-value <0.0001, z-value = −5.1) and HEPA filtration (p-value = 0.0037, z-value = −2.7). Table 1 summarizes indoor and outdoor concentrations.

We present detailed results in the following sections where we have organized our lines of reasoning as follows: first, we demonstrate elevated outdoor PNC during different impact-sector winds in the two study areas (each showing an impact when it was oriented downwind of the airport) including sites upwind and downwind of a highway; second, we discuss correlation of outdoor PNC with wind speed and flight activity, which indicated the aviation-related origin of elevated PNC during impact-sector winds; and third, we report indoor trends at all residences and discuss indoor infiltration of aviation-related, elevated, outdoor PNC for two residences in detail.

Wind Direction and Ambient PNC Patterns at Residences. Higher ambient PNC were observed during winds that positioned the sites downwind of the airport (i.e., impact-sector winds). Impact sector differed by study area and from residence to residence within the study areas. In Chelsea (located NW of the airport) PNC were elevated during SE winds and in Boston (located SW of the airport) PNC were elevated during NE winds (Figure 1). This impact is thus spatially widely distributed in the Boston area.

Chelsea. During impact-sector winds in the Chelsea study area (ESE-S, 111°−182°), PNC were elevated at the central site and all seven residences. Residences that were upwind of the highway during impact-sector winds are denoted with a U, residences that were downwind of the highway during impact-sector winds are denoted as D, and community sites that are

DOI: 10.1021/acs.est.7b05593
Environ. Sci. Technol. XXXX, XXX, XXX−XXX

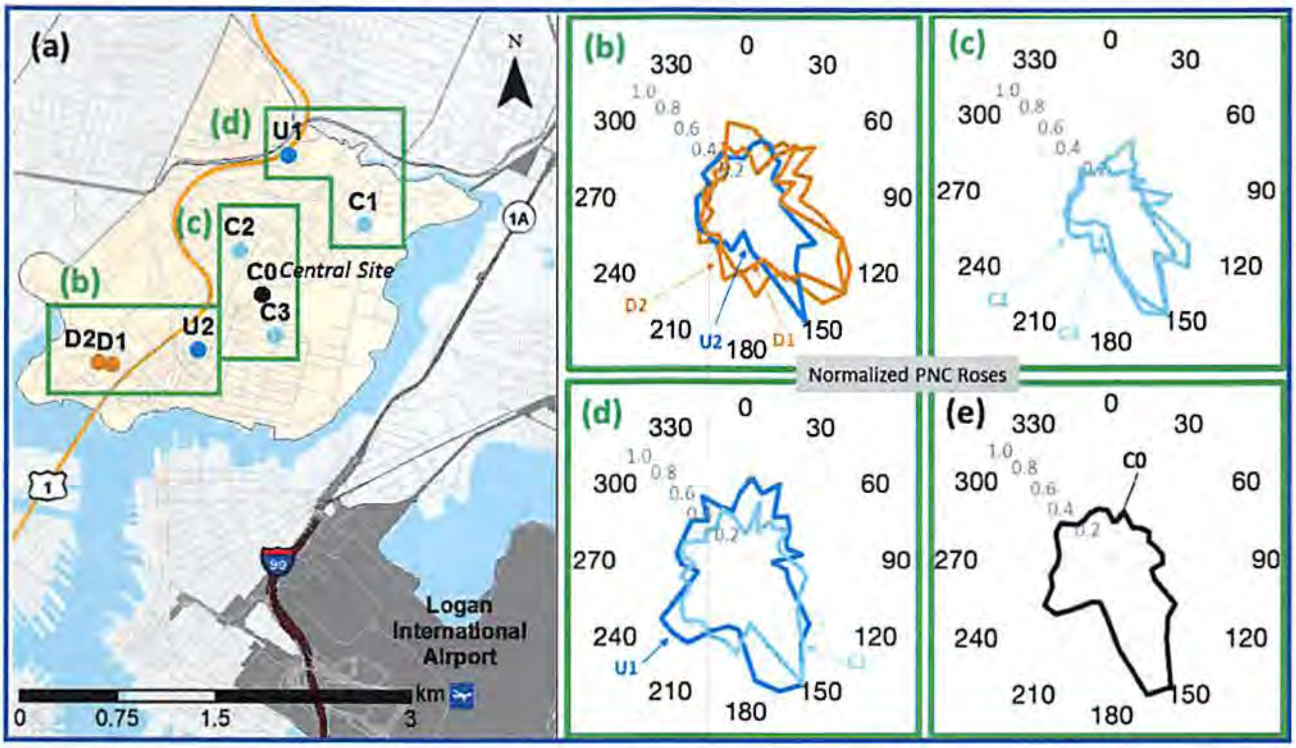


Figure 2. (a) Locations of the central site (C0, black) and seven residences monitored in Chelsea. Residences were classified as upwind (U, dark blue) of the highway during impact-sector winds, downwind of the highway (D, orange) during impact-sector winds and community sites that were not in proximity of the highway (C, light blue). (b)−(e) Normalized (by the maximum) PNC roses are based on hourly medians; concentric circles are increments of 0.2 on a 0−1 scale.

not in proximity of a highway are denoted as C (Figure 2). Median PNC during impact-sector winds were 1.6- to 3.0-fold higher than the medians for all other winds (Table 1). Highest and lowest residential impact-sector medians were 37 000 and 13 000 particles/cm^3, respectively, as compared to 16 000 and 8000 particles/cm^3 during all other winds.

Impact-sector winds occurred for 4.7−11.8% of the time (annually, ~ 7% in 2014) during the residential monitoring, but their weighted contributions to the monitoring averages were 8−26%. It should be noted that these contributions likely include some input from other sources in impact sectors, such as, traffic. Heatmaps of PNC by wind direction and hour of the day for the central site and all seven residences studied in Chelsea (SI Figure S3 (a) and (c)) indicate PNC peaks coincided with morning and evening vehicular and aviation traffic rush-hours. However, these peaks were highly elevated during impact-sector winds even though traffic impacts are not particularly concentrated in the impact sector; only two of the seven residences (D1 and D2) were downwind of major roadways and highways during impact-sector winds.

Boston. In the Boston study area, a pronounced increase in PNC during impact-sector winds was evident at three sites 5.0−6.1 km downwind of the airport (Figure 3). At residences U1 and U2 (NNE-ENE, 28°−61°), which were both also upwind of Interstate 93 (I-93) (Figure 3(b)), median PNC during impact-sector winds were 25 000 and 20 000 particles/cm^3, respectively, as compared to 15 000 and 10 000 particles/cm^3 during all other winds. At site D1, which was 6.1 km downwind of the airport and 200 m downwind of I-93 during impact-sector (NE) winds, but impacted by the highway during both NE (31°−59°) and SE (115°−145°) winds, median PNC were greater during NE winds than during SE winds (29 000 vs 19 000 particles/cm^3, respectively; means were 29 000 ± 46% vs 21 000 ± 70% particles/cm^3, respectively) for similar I-93 traffic volume (hourly traffic flow was 7000 ± 47% during times of NE vs 8000 ± 39% during SE winds).

At the other six sites in Boston, which were 6.8−10.0 km from the airport, increases in PNC during impact-sector winds were not as distinct (Figure 3(c)). Ambient median PNC during impact-sector winds, which likely included considerable contributions from upwind sources including busy roadways and highways in Boston, were 1.1- to 1.6-fold higher at these six residences than the medians for all other winds (Table 1). Heatmaps for PNC by wind direction and time of day for the central site and all residences (SI Figure S3 (b) and (d)) indicate PNC peaks coincided with morning and evening vehicular and aviation traffic rush-hours. The impact-sector PNC were lower in Boston compared to Chelsea.[15]

Correlations between PNC and Wind Speed. Because higher wind speeds generally promote greater dispersion and mixing, PNC and wind speed are typically negatively correlated. However, for buoyant aviation emissions plumes, higher wind speeds promote faster ground arrival counterbalancing the increased dilution.[18] Thus, a distinct feature of aviation emissions impacts (unlike road traffic emissions impacts) is a lack of negative correlation between PNC and wind speed.[4,19,20] We too observed this phenomenon. During impact-sector winds at Chelsea and Boston central-sites, the negative correlation between PNC and wind speed was lacking; correlation coefficients were r_S = 0.17 and 0.19, n = 435 and 408 h, respectively, and p-value < 0.001. In contrast, during other winds, the expected negative correlation between PNC and wind speed was observed (r_S = −0.24 and −0.05, n = 7552 and 10 537 h, respectively, and p-value < 0.001). Similar trends

DOI: 10.1021/acs.est.7b05593
Environ. Sci. Technol. XXXX, XXX, XXX−XXX

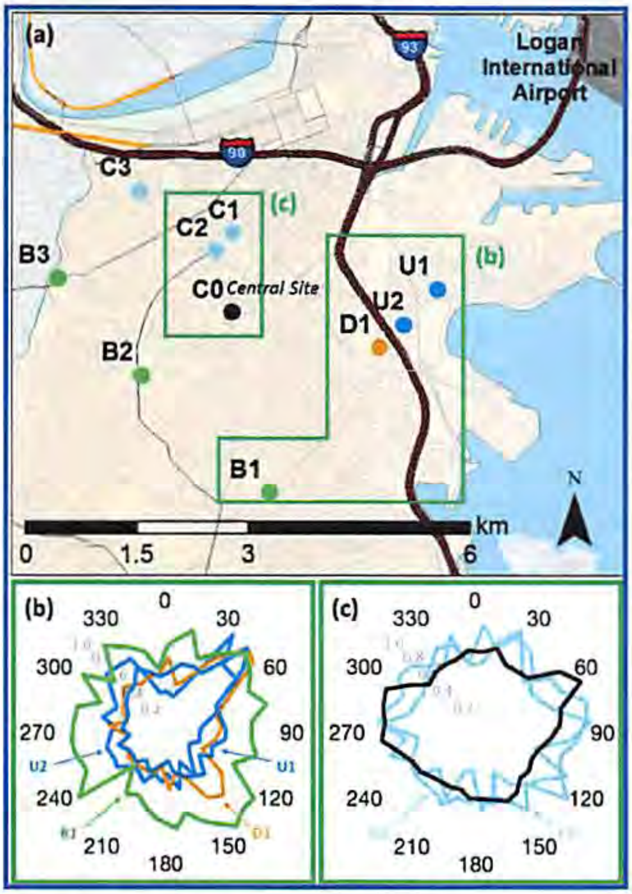


Figure 3. (a) Locations of the central site (C0, black) and nine residences monitored in Boston. Residences were classified as upwind (U, dark blue) of the highway during impact-sector winds, downwind of the highway (D, orange) during impact-sector winds, community sites (C, light blue) and background sites (B, green). (b)–(c) Normalized (by the maximum) PNC roses are based on hourly medians; concentric circles are increments of 0.2 on a 0–1 scale.

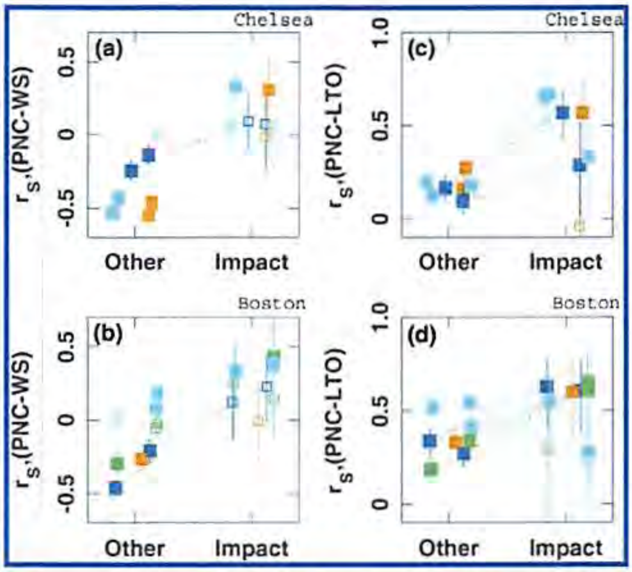


Figure 4. Correlation coefficients between outdoor PNC and wind speed (a, b) and LTO (c, d) for seven Chelsea and nine Boston residences during impact-sector and other winds. Filled squares represent significant correlation (p-value <0.05) and unfilled squares represent insignificant correlations. X-axis is categorical but points have been jittered to enhance visual clarity by reducing overlap. For description of colors, see captions for Figures 2 and 3.

were found at the residences in both study areas: correlation between PNC and wind speed was either lacking or even positive during impact-sector winds but it was negative during other winds. Correlation coefficients for residences are shown in Figure 4 where points have been jittered along the categorical x-axis to reduce overlap.

Because impact-sector winds were a small fraction of all winds (3–12% of the total data set) we conducted bootstrap resampling of correlation estimates (r_S) and bootstrap subsampling of a similarly small data set from other wind conditions to ensure that the lack of negative correlation was not by chance. The correlation estimates during impact-sector winds were different from the negative estimates obtained for other winds; results are shown in SI Figure S4–S19. The contrast in correlation was most evident in Chelsea and sites upwind of I-93 in Boston. Notable exceptions were sites downwind of both a highway and the airport during impact-sector winds likely because they were dominantly impacted by highway emissions given their proximity to the highways. For example, at site D1 in Boston, we observed no difference in correlation estimates between impact-sector and other winds (SI Figure S11). In comparison, at sites U1 and U2 in Boston, which were upwind of the highway during impact-sector winds but still downwind of the airport, correlation estimates were positive during impact-sector winds and negative during other winds (SI Figure S12–S13).

Correlations between PNC and Flight Activity. PNC at both central sites were previously reported to be positively correlated with aviation activity (measured as LTO, the hourly total landings and takeoffs) after controlling for traffic volume, time of day and week, and meteorological factors (wind speed, temperature, and solar radiation).[4] Because the central sites both had relatively large data sets (several years of monitoring), we were able to control for these factors; however, the relatively small PNC data sets for residences and the lack of local traffic volume information limited meaningful controls in the current analysis. Also, because the temporal patterns of flight activity and vehicle traffic are similar, some confounding was observed between PNC and LTO irrespective of the wind direction. For example, Pearson's correlation coefficient for hourly LTO and traffic volume on I-93 in 2012 was 0.85. Nonetheless, Spearman's correlations and the bootstrap analysis (SI Figure S20–S35) indicate that PNC versus LTO correlation estimates during impact-sector winds were generally higher than during other winds; that is, r_s ranged from 0.29 to 0.67 during impact-sector winds compared to 0.10–0.54 during other winds, but there were exceptions (see discussion in SI).

Indoor Infiltration of PNC during Impact-Sector Winds. *Overall Trend at Residences.* Infiltration of aviation-related outdoor PNC was evident in the data as higher indoor concentrations during impact-sector winds compared to other winds. The median increase in indoor concentrations during impact-sector winds compared to other winds was 1.7-fold (range: 0.9–3.1-fold). PNC measurements (median and minimums) are summarized in Table 1 for all residences. For trends with respect to wind direction for individual residences see SI Figures S36–S51, which show an increase in indoor medians coincident with impact-sector winds is more apparent for residences in Chelsea and Boston closer to the airport, while

DOI: 10.1021/acs.est.7b05593
Environ. Sci. Technol. XXXX, XXX, XXX–XXX

some residences located farthest away (like B1 and B2) showed no trend with respect to wind direction for either outdoor or indoor PNC.

HEPA filtration lowered the indoor concentrations; indoor-to-outdoor PNC ratios were 0.33 ± 0.17 lower during HEPA filtration as compared to sham filtration (see Brugge et al.[16]). Figure 5 compares 10°-wide-sector PNC medians for impact-sector and other winds separately for sham and HEPA filtration scenarios in all 16 homes. Because filtration efficiency is not preferential to ambient wind direction, higher concentrations (despite lower indoor-to-outdoor ratios) were still observed during impact-sector winds. Further, this trend was apparent in both the hourly medians and hourly minimums (range: 0.8–2.9-fold) of indoor PNC even though hourly medians are more likely to be skewed by contributions from indoor sources than the hourly minimums (SI Figure S52).

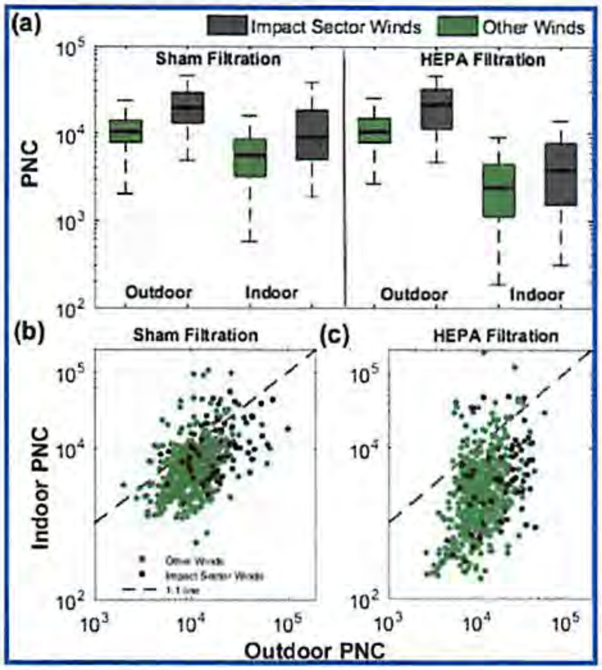


Figure 5. (a) Tukey's boxplots of indoor and outdoor PNC data during sham and HEPA filtration from all 16 homes. The horizontal line inside each box is the median; the boxes extend from the 25th to the 75th percentile and the whiskers extend to 1.5*interquartile range. In (b) and (c) each point in the scatterplots represents the median of hourly medians classified into 10-degree-wide wind sectors.

Previous studies have shown that ambient PNC infiltrate indoors via multiple pathways such as forced air ventilation systems, open windows, or cracks in the building envelope.[21] Infiltration factors vary from 0.03 to 1.0[21,22] in the ultrafine range, the size range for the majority of the aviation-related particulate emissions.[3] Infiltration of aviation-related PNC and, resultantly, an increase in indoor PNC and residential exposures can thus be expected in near-airport residences. Our results clearly indicate that to be the case; particles of aviation-related origin infiltrate residences. Two cases are illustrated in detail in the following section.

Illustration of Infiltration at Select Residences. Infiltration of PNC is illustrated for residence C3 in Chelsea in Figure 6 (a). Time series of indoor PNC closely followed the same pattern as outdoor PNC during an 18-h period of consistent

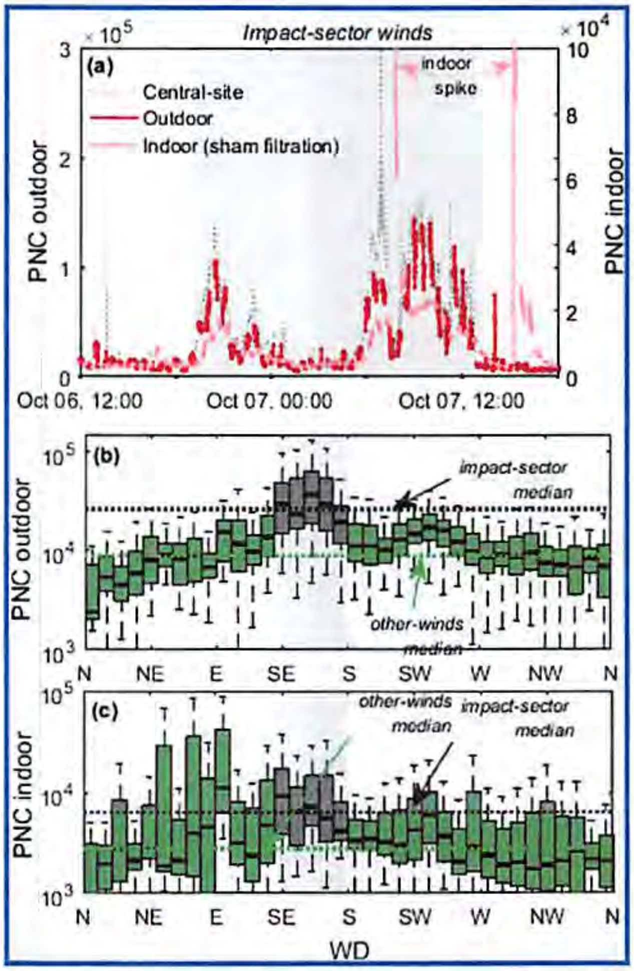


Figure 6. PNC time series for October 6–7, 2014 for site C3 in Chelsea is shown in (a). Impact-sector winds are highlighted in gray. Tukey's boxplots in (b) and (c) show outdoor and indoor PNC. The horizontal line inside each box is the median, the boxes extend from the 25th to the 75th percentile and the whiskers extend to 1.5*interquartile range.

impact-sector winds (from 1900 h on Oct 6 to 1200 h on Oct 7, 2014). During hours of minimal flight activity (0100–0500 h; LTO = 1.5 h^{-1}), PNC indoors and outdoors at C3 and the central site were all low but increased as flight activity resumed after ~0500 h. Residential outdoor PNC was also remarkably highly correlated (Pearson's $r = 0.96$) with the central site located 1 km away indicating the spatial homogeneity of the aviation-related impact over a large area. Further, even though it was past the evening traffic rush-hour period (and thus traffic would have contributed minimally to the observations or for that matter particle formation) when the winds shifted (at ~1900 h) to the impact sector, outdoor and central-site concentrations increased to high levels (1 min averages were between 50 000 and 100 000 particles/cm^3), which underscores the magnitude of this impact. In comparison, Simon et al.[15] reported mean 1 min on-road PNC from 180 h of mobile monitoring across Chelsea including traffic rush-hours was 32 000 particles/cm^3 which was about one third to one half of the observed PNC at C3 during impact-sector winds. Overall, at C3, the median indoor PNC was nearly 3-fold higher for impact-sector winds compared to other winds (8900 versus 2800 particle/cm^3) (Figure 6(c), SI Figure S42).

DOI: 10.1021/acs.est.7b05593
Environ. Sci. Technol. XXXX, XXX, XXX–XXX

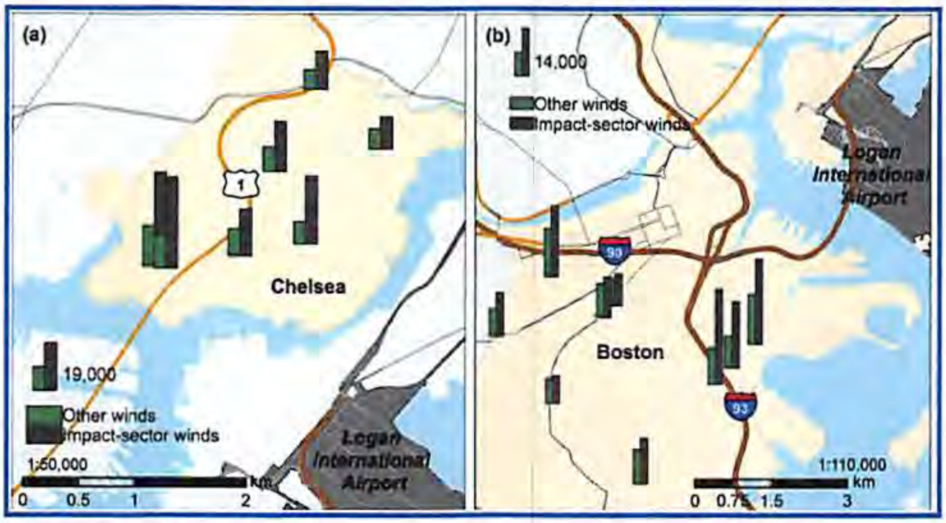


Figure 7. Outdoor PNC at residences during six-week monitoring periods in Chelsea (a) and Boston (b). Median of hourly medians classified as impact-sector and other winds are shown.

Another example of infiltration is shown in Figure S53(a) where a 22-h period of generally consistent impact-sector winds is highlighted (from 1900 h on Nov 6 to 1700 h on Nov 7, 2012) for residence U1 from the Boston study area. U1 is relatively close to I-93 but it is upwind of the highway during impact-sector winds. Outdoor concentrations during impact-sector winds from 1900 h to as late as midnight on Nov 6−7, 2012 were ~40 000 particles/cm^3 but then decreased to as low as 2000 particles/cm^3 during the hours of low flight activity at the airport (LTO decreased from 32 h^{-1} to 2.8 h^{-1} during 1900−0000 h to 0000−0500 h). The indoor PNC time series was consistent with the outdoor concentration during these hours. Both outdoor and indoor concentration started increasing again around 0500 h when flight activity resumed at the airport; however, around 0800 h indoor PNC spiked, likely from an indoor particle-generation event that dominated indoor PNC during the following hours despite impact-sector winds. Overall, the median indoor PNC was 2-fold higher for impact-sector winds compared to other winds (15 000 versus 7400 particles/cm^3) (Figure S53(c) and Figure S44).

Strength and Limitations. To our knowledge this is the first investigation of the impacts of aviation-related emissions at residences around airports. Our results show an increase in outdoor as well as indoor PNC. These findings point to the need for studies to provide further characterization of these impacts (e.g., measure additional pollutants in a greater number and variety of residences both near and far from airports and under a greater diversity of meteorological conditions and indoor activities).

Our study also had limitations. The foremost is that monitoring was not specifically designed for quantifying the impacts of aviation-related emissions on indoor and outdoor PNC. Data were collected as part of the Boston Puerto Rican Health Study (a study of exposure to urban air pollution and cardiovascular health effects in a Puerto Rican cohort[23]), but it allowed for the reported analysis because of the residences' proximity to and distribution around the airport. Ideally, for quantifying the aviation-related impacts and distinguishing them from other outdoor sources (such as traffic) and indoor sources (such as cooking), continuous indoor and outdoor monitoring at several locations in carefully characterized residences with indoor time-activity records would be necessary. In addition, the study was not designed to characterize the air exchange rates or infiltration factors for ambient particles. As a result, we could not quantify the contribution of indoor- versus outdoor-origin PNC to total indoor observations, or more pertinently the contribution from aviation-related outdoor PNC to indoor observations. Further, the lack of concurrent data from all or even multiple residences precluded spatial analysis. Residence-to-residence differences in outdoor and indoor PNC (Figure 7 and Table 1) were observed. For example, at sites closer to the airport PNC were generally higher than farther away, but at sites immediately downwind of highways, even though they were farther downwind of the airport, PNC were even higher, likely due to impacts from both aviation-related and traffic emissions. Such spatial differences were not investigated. Observed outdoor concentration differences were likely not solely due to the differences in spatial location with respect to the airport or other sources; temporal differences (e.g., meteorological and seasonal factors) likely also contributed significantly, but they could not be controlled for due to lack of concurrent data.

Significance of the Results. Altogether, our results make a compelling case for further investigation of aviation-related air pollution impacts and resulting exposures because these impacts are not expected to be unique to Logan airport. Extrapolating from Correia et al.[13], we estimate that in the United States ~40 million people live near 89 major airports (i.e., within areas with ≥45 dB noise levels near airports). Inclusion of aviation-related impacts may also improve predictive models for exposure assessments. Future studies of this impact with concurrently located sites that allow analysis of the spatial gradient and comparison with traffic impacts could be very informative for ultrafine particle epidemiology.

■ ASSOCIATED CONTENT

Ⓢ Supporting Information

The Supporting Information is available free of charge on the ACS Publications website at DOI: 10.1021/acs.est.7b05593.

Information related to flight activity at Logan International Airport (Figure S1), details of monitoring schedule residence characteristics, and summary statistics of the

data (Table S1–S6, Figure S2), heatmaps of PNC by wind direction and time of the day (Figure S3), correlation coefficient estimates from bootstrap subsampling and resampling (Figure S4–S35), additional graphics related to particle number concentration trends with respect to wind direction at monitoring sites (Figure S36–S52) and an example of infiltration (Figure S53) (PDF)

AUTHOR INFORMATION

Corresponding Author

*Phone: 617.627.5489; fax: 617.627.3994; e-mail: neelakshi.hudda@tufts.edu.

ORCID

N. Hudda: 0000-0002-2886-5458

Notes

The authors declare no competing financial interest.

ACKNOWLEDGMENTS

We are grateful to Alex Bob, Dana Harada, Joanna Stowell, Hanaa Rohman, Ruhui Zhao, and Andrew Shapero for fieldwork assistance. Alexis Soto and Nancy Figueroa recruited participants for residential monitoring. Marianne Ray helped with data analysis. We would like to thank The Neighborhood Developers (Chelsea, MA) and Massachusetts Department of Environmental Protection (Roxbury, MA) for providing space and electricity for our monitoring equipment. This work was funded by NIH grants P01 AG023394 and P50 HL105185 to the University of Massachusetts Lowell, NIH-NIEHS grant ES015462 to Tufts University, and by the Somerville Transportation Equity Partnership (STEP).

REFERENCES

(1) Hudda, N.; Gould, T.; Hartin, K.; Larson, T. V.; Fruin, S. A. Emissions from an international airport increase particle number concentrations 4-fold at 10 km downwind. *Environ. Sci. Technol.* **2014**, *48* (12), 6628–6635.

(2) Keuken, M. P.; Moerman, M.; Zandveld, P.; Henzing, J. S.; Hoek, G. Total and size-resolved particle number and black carbon concentrations in urban areas near Schiphol airport (the Netherlands). *Atmos. Environ.* **2015**, *104*, 132–142.

(3) Hudda, N.; Fruin, S. A. International Airport Impacts to Air Quality: Size and Related Properties of Large Increases in Ultrafine Particle Number Concentrations. *Environ. Sci. Technol.* **2016**, *50* (7), 3362–3370.

(4) Hudda, N.; Simon, M. C.; Zamore, W.; Brugge, D.; Durant, J. L. Aviation Emissions Impact Ambient Ultrafine Particle Concentrations in the Greater Boston Area. *Environ. Sci. Technol.* **2016**, *50* (16), 8514–8521.

(5) Geiser, M.; Rothen-Rutishauser, B.; Kapp, N.; Schürch, S.; Kreyling, W.; Schulz, H.; Semmler, M.; Im Hof, V.; Heyder, J.; Gehr, P. Ultrafine particles cross cellular membranes by nonphagocytic mechanisms in lungs and in cultured cells. *Environ. Health Perspect.* **2005**, *113* (11), 1555–1560.

(6) HEI Review Panel. *Understanding the Health Effects of Ambient Ultrafine Particles*; Health Effects. Institute, January, **2013**, 122.

(7) Oberdorster, G.; Oberdorster, E.; Oberdorster, J. Nanotoxicology: An emerging discipline evolving from studies of ultrafine particles. *Environ. Health Perspect.* **2005**, *113* (7), 823–839.

(8) van Nunen, E.; Vermeulen, R.; Tsai, M.-Y.; Probst-Hensch, N.; Ineichen, A.; Davey, M.; Imboden, M.; Ducret-Stich, R.; Naccarati, A.; Raffaele, D.; et al. Land Use Regression Models for Ultrafine Particles in Six European Areas. *Environ. Sci. Technol.* **2017**, *51* (6), 3336–3345.

(9) Hatzopoulou, M.; Valois, M. F.; Levy, I.; Mihele, C.; Lu, G.; Bagg, S.; Minet, L.; Brook, J. Robustness of Land-Use Regression Models Developed from Mobile Air Pollutant Measurements. *Environ. Sci. Technol.* **2017**, *51* (7), 3938–3947.

(10) Weichenthal, S.; Ryswyk, K. V; Goldstein, A.; Bagg, S.; Shekkarizfard, M.; Hatzopoulou, M. A land use regression model for ambient ultrafine particles in Montreal, Canada: A comparison of linear regression and a machine learning approach. *Environ. Res.* **2016**, *146*, 65–72.

(11) Kerckhoffs, J.; Hoek, G.; Messier, K. P.; Brunekreef, B.; Meliefste, K.; Klompmaker, J. O.; Vermeulen, R. Comparison of Ultrafine Particle and Black Carbon Concentration Predictions from a Mobile and Short-Term Stationary Land-Use Regression Model. *Environ. Sci. Technol.* **2016**, *50* (23), 12894–12902.

(12) Eeftens, M.; Phuleria, H. C.; Meier, R.; Aguilera, I.; Corradi, E.; Davey, M.; Ducret-Stich, R.; Fierz, M.; Gehrig, R.; Ineichen, A.; et al. Spatial and temporal variability of ultrafine particles, NO2, PM2.5, PM2.5 absorbance, PM10 and PMcoarse in Swiss study areas. *Atmos. Environ.* **2015**, *111* (2), 60–70.

(13) Correia, A. W.; Peters, J. L.; Levy, J. I.; Melly, S.; Dominici, F. Residential exposure to aircraft noise and hospital admissions for cardiovascular diseases: multi-airport retrospective study. *BMJ.* **2013**, *347* (oct08_3), f5561.

(14) Hansell, A. L.; Blangiardo, M.; Fortunato, L.; Floud, S.; de Hoogh, K.; Fecht, D.; Ghosh, R. E.; Laszlo, H. E.; Pearson, C.; Beale, L.; et al. Aircraft noise and cardiovascular disease near Heathrow airport in London: small area study. *BMJ.* **2013**, *347* (oct08_3), f5432.

(15) Simon, M. C.; Hudda, N.; Naumova, E. N.; Levy, J. I.; Brugge, D.; Durant, J. L. Comparisons of traffic-related ultrafine particle number concentrations measured in two urban areas by central, residential, and mobile monitoring. *Atmos. Environ.* **2017**, *169*, 113–127.

(16) Brugge, D.; Simon, M. C.; Hudda, N.; Zellmer, M.; Corlin, L.; Cleland, S.; Lu, E. Y.; Rivera, S.; Byrne, M.; Chung, M.; et al. Lessons from in-home air filtration intervention trials to reduce urban ultrafine particle number concentrations. *Build. Environ.* **2017**, *126*, 266–275.

(17) Environmental Protection Agency. AERMINUTE User's Instructions; 2011.

(18) Seinfeld, J. H.; Pandis, S. N. *Atmospheric Chemistry and Physics: From Air Pollution to Climate Change*, 2006.

(19) Carslaw, D. C.; Beevers, S. D.; Ropkins, K.; Bell, M. C. Detecting and quantifying aircraft and other on-airport contributions to ambient nitrogen oxides in the vicinity of a large international airport. *Atmos. Environ.* **2006**, *40* (28), 5424–5434.

(20) Barrett, S. R. H.; Britter, R. E.; Waitz, I. A. Impact of aircraft plume dynamics on airport local air quality. *Atmos. Environ.* **2013**, *74* (2), 247–258.

(21) Rim, D.; Wallace, L.; Persily, A. Infiltration of Outdoor Ultrafine Particles into a Test House. *Environ. Sci. Technol.* **2010**, *44* (15), 5908–5913.

(22) Long, C. M.; Suh, H. H.; Catalano, P. J. A.; Koutrakis, P. Using Time- and Size-Resolved Particulate Data To Quantify Indoor Penetration and Deposition Behavior. *Environ. Sci. Technol.* **2001**, *35* (10), 2089–2099.

(23) Tucker, K. L.; Mattei, J.; Noel, S. E.; Collado, B. M.; Mendez, J.; Nelson, J.; Griffith, J.; Ordovas, J. M.; Falcon, L. M. The Boston Puerto Rican Health Study, a longitudinal cohort study on health disparities in Puerto Rican adults: challenges and opportunities. *BMC Public Health* **2010**, *10* (1), 107.

Environmental Science & Technology

Article

pubs.acs.org/est

Terms of Use

Emissions from an International Airport Increase Particle Number Concentrations 4-fold at 10 km Downwind

Neelakshi Hudda,[†] Tim Gould,[‡] Kris Hartin,[§] Timothy V. Larson,[‡] and Scott A. Fruin*[,†,∥]

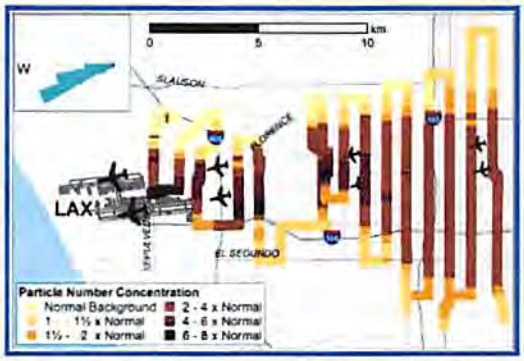
[†]Keck School of Medicine, Department of Preventive Medicine, University of Southern California, Los Angeles, California 90089, United States

[‡]Department of Civil and Environmental Engineering, University of Washington, Seattle, Washington 98195, United States

[§]Department of Environmental and Occupational Health Sciences, University of Washington, Seattle, Washington 98195, United States

Supporting Information

ABSTRACT: We measured the spatial pattern of particle number (PN) concentrations downwind from the Los Angeles International Airport (LAX) with an instrumented vehicle that enabled us to cover larger areas than allowed by traditional stationary measurements. LAX emissions adversely impacted air quality much farther than reported in previous airport studies. We measured at least a 2-fold increase in PN concentrations over unimpacted baseline PN concentrations during most hours of the day in an area of about 60 km^2 that extended to 16 km (10 miles) downwind and a 4- to 5-fold increase to 8–10 km (5–6 miles) downwind. Locations of maximum PN concentrations were aligned to eastern, downwind jet trajectories during prevailing westerly winds and to 8 km downwind concentrations exceeded 75 000 particles/cm^3, more than the average freeway PN concentration in Los Angeles. During infrequent northerly winds, the impact area remained large but shifted to south of the airport. The freeway length that would cause an impact equivalent to that measured in this study (i.e., PN concentration increases weighted by the area impacted) was estimated to be 280–790 km. The total freeway length in Los Angeles is 1500 km. These results suggest that airport emissions are a major source of PN in Los Angeles that are of the same general magnitude as the entire urban freeway network. They also indicate that the air quality impact areas of major airports may have been seriously underestimated.



INTRODUCTION

Previous studies that directly measured the impact of aviation activity on air quality have mostly conducted measurements in close proximity of airports. Few studies have reported significant air quality impacts extending beyond a kilometer.[1−4] Carslaw et al. 2006[1] analyzed differences in pollutant concentrations by wind speed and direction along with differences in aircraft and ground traffic activity at Heathrow Airport in London. They found airport contributions of up to 15% of total oxides of nitrogen (NO_x) at a site 1.5 km downwind of the nearest runway. At Hong Kong International Airport, Yu et al. 2004[2] used nonparametric regression analysis on pollutant concentrations by wind speed and direction. They calculated that aircraft nearly doubled sulfur dioxide concentrations 3 km away and also increased concentrations of carbon monoxide and respirable suspended particles under similar wind speeds and directions. Fanning et al. 2007[3] measured particle numbers concentrations in the 10–100 nm range and found significant increases above background at 1.9, 2.7, and 3.3 km downwind of the Los Angeles International Airport (LAX) blast fence. Although measurements were stationary and not concurrent, they also noted that takeoffs produced high concentrations and downwind gradients within 600 m of the blast fence. Dodson et al. 2009[4] found that aircraft activity at a regional airport in Warwick, RI contributed 24–28% of the total black carbon (BC) measured at five sites 0.16–3.7 km from the airport.

Several other airport and aviation emissions studies focused on quantifying the air quality impacts from jet takeoffs[5,6] and measured air pollutant concentrations very close to runways. Of particular relevance to this study, Hsu et al. 2013[7] linked flight activity at LAX with 1 min average PN concentrations. Their models suggested that aircraft produced a median PN concentration of nearly 150 000 particles/cm^3 at the end of the departure runway. PN concentrations decreased rapidly with distance to 19 000 particles/cm^3 at a location 250 m downwind and to 17 000 particles/cm^3 at a location 500 m further downwind. The rapid drop-off in concentration, however, may have reflected an increasing offset from the centerline of impacts with greater downwind measurement distance. Similar magnitude PN concentrations and correlations

Received: January 22, 2014
Revised: May 12, 2014
Accepted: May 14, 2014
Published: May 29, 2014

with departures were reported by Westerdahl et al. 2008[8] and Zhu et al. 2011[9] at sites located within 100–200 m of the Hsu et al. 2013[7] measurements.

Our study was motivated by mobile monitoring platform (MMP) based observations of large but gradual increases in PN concentrations as we approached locations under LAX jet landing trajectories on multiple transects up to 10 km downwind of LAX. We hypothesized that emissions from LAX activities were increasing PN concentrations over much larger areas and longer downwind distances than previously observed in studies that focused on near freeway and jet takeoff impacts to air quality. An extensive monitoring campaign confirmed that LAX-related emissions increased PN concentrations downwind at least 2-fold to 16 km. This large, previously undiscovered spatial extent of the air quality impacts downwind of major airports may mean a significant fraction of urban dwellers living near airports likely receive most of their outdoor PN exposure from airports rather than roadway traffic.

■ MATERIALS AND METHODS

Monitoring Area. LAX is the sixth busiest airport in the world and third busiest in the United States. About 95% of flights take off and land into the prevailing westerly/west-southwesterly (W/WSW) onshore winds[10] (i.e., 263 degrees, the direction of runway alignment[2]) using two sets of parallel runways separated by about 1.5 km. In the busiest hours, 40–60 jets per hour arrive during hours 0700–1900 and depart during hours 0800–2100. Reduced activity is typical for the early morning and late evening hours. 20–40 jets per hour arrive during hours 0600 and 1000–0100 and depart during hours 0700 and 2200–2300. During other hours typically fewer than five jets per hour arrive or depart.[10]

The airport complex is about 4.5 km east to west (E-W) and about 2.5 km north to south (N–S) and is surrounded by major roadways and freeways, as highlighted in Figure 1 (Figure

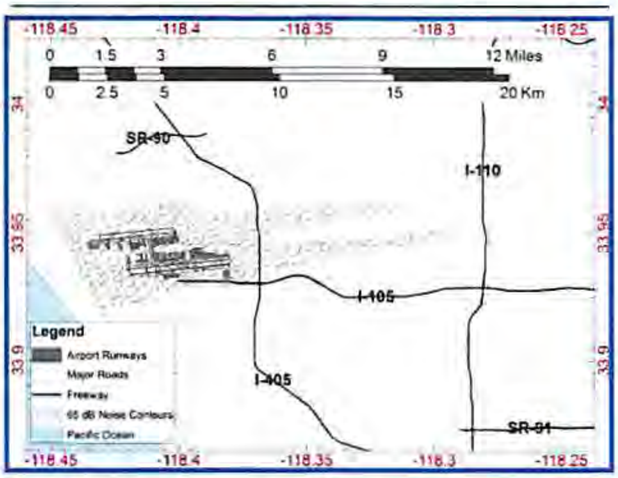


Figure 1. Los Angeles International Airport and 65 dB noise contours indicating eastern jet trajectories.

S.1 in Supporting Information (SI) shows a map of this area with street name labels). The Federal Aviation Administration noise contours of the modeled annual 65 dB A-weighted equivalent (L_{Aeq}) noise threshold are shown[11] extending eastward along the predominant downwind direction and reflect the jet trajectories used for landing. They also extend west of the airport over the Pacific Ocean (not shown).

Mobile Monitoring. Monitoring consisted of transects 4–16 km in length, nearly perpendicular (i.e., N–S) to the direction of the prevailing winds, at varying downwind distances. Different monitoring routes were required to fully capture the changes in impact locations due to shifts in wind direction. A general downwind direction was chosen based on meteorological predictions but transect lengths and locations were determined during the monitoring run based on observations of the rate of change of PN concentrations. For each transect, monitoring was extended several hundred meters beyond the location where baseline PN concentrations appeared stable.

Measurements were conducted over 29 days with the University of Southern California (USC) MMP, a gasoline-powered hybrid vehicle. A second MMP, the University of Washington (UW) MMP, a gasoline-powered minivan, joined the monitoring on 3 days (June 22, 27 and July 1, 2013). Table 1 gives monitoring dates and times.

Most measurements were conducted during times of onshore westerly winds, typically strongest during 1100–1600, but we also conducted measurements during early morning and late night hours when air traffic was low and onshore winds were reduced (August 13, 16, 23, 24 and 25, December 03, 09, 15 and 16, 2013). Monitoring focused on the area east of LAX (i.e., the predominant downwind direction) but included several runs along the boundary of the airport in the upwind direction and south of the airport complex during occasions of northerly winds in winter months.

Instrumentation. Concentration measurements included PN, BC, NO, NO_2, NO_x, and particle surface UV-photo-ionization potential (measured using Ecochem Photoelectric Aerosol Sensor [PAS] that responds to elemental carbon and particle-bound polycyclic aromatic hydrocarbons [PB–PAH]). Instrument details are provided in SI (Table S.1 and S.2). Instruments were powered by two deep-cycle marine batteries via DC-to-AC inverter. Our power arrangement allowed for 5 h of run time if all instruments were running. For sampling runs that were anticipated to exceed 5 h, several instruments were shut down to extend battery life and the Condensation Particle Counter (CPC) was run on the vehicle's 12 V cell phone power outlet. If other instruments were turned on later, the required warm-up time was 25 min.

Instrument clock times were regularly synchronized to be within 1 s of the global positioning system device time, which also recorded speed and location. Measurements from instruments with a delayed response time were advanced to match the instantaneous instruments and the GPS time and location recorded at 1 s intervals. For pollutant measurements recorded at 10 s intervals, all locations within the recording interval were assigned the pollutant value reported for that interval.

Meteorological Data. Minute and hourly wind speed and wind direction data were obtained from the Automated Surface Observing Systems monitor at LAX airport (latitude 33.943 and longitude −118.407). Due to the 16 km distance between eastern edge of the study area and the meteorological station located at LAX, we could not assume that wind speed and direction were identical to those measured at LAX, but wind direction in this region of Los Angeles tends to be similar over large areas during daytime.[12]

The average wind direction at LAX is WSW (252°).[12] Daytime southwesterly sea breezes typically occur 16 h per day in the summer (0900–0100 for June–August), decreasing to 6

dx.doi.org/10.1021/es5001566 | Environ. Sci. Technol. 2014, 48, 6628–6635

Table 1. Sampling Days, Time Periods and Meteorological Conditions during Sampling

date[a]	time	sampling distance from LAX (km)	WD[b]	WS (m/s)	urban background PN[c]	ratio of impacted to unimpacted baseline PN, 10 km downwind
4/6/2011	14:30–16:45	8–12	WSW, W	5.0 ± 1.8	15 000	2.0
4/10/2011	15:00–17:30	8–12	W	6.9 ± 1.2	10 000	4.5
5/24/2011	09:00–11:00	8–12	Calm, W	1.0 ± 2.5	10 000	3.0
5/27/2011	12:15–14:45	8–12	WSW, W	6.3 ± 1.3	10 000	4.7
1/26/2012	17:28–20:22	8–12	WSW, W	2.9 ± 2.1	20 000	6.0
9/29/2012	13:30–17:30	0–8	W	6.1 ± 1.1	10 000	3.7
9/30/2012	15:45–18:30	0–8	W	6.1 ± 0.4	5000	5.2
6/11/2013	14:14–15:14	2.5–8.5	WSW, W	6.7 ± 0.0	15 000	5.0
6/12/2013	13:30–16:30	2.5–10.5	W	4.0 ± 0.4	15 000	4.0
6/22/2013	11:47–18:50[d]	0–8	WSW, W	5.7 ± 0.4	10 000	4.4
6/27/2013	11:49–18:00[d]	0–8	WSW, W	5.3 ± 0.7	10 000	4.0
7/01/2013	10:30–18:30[d]	0–8	W, ESE	3.8 ± 1.0	15 000	3.8[e]
8/6,7/2013	23:56–02:45	0–8	WSW, W, S	3.3 ± 0.7	10 000	3.3
8/13/2013	06:30–15:00	0–8	Calm, WSW, W, NNE, NE, ENE, E, ESE[f]	3.0 ± 2.0	10 000	4.0
8/15/2013	08:30–15:30	0–16	Calm, WSW,W	2.5 ± 2.1	20 000	3.8
8/16/2013	09:45–20:50	0–16	SW, WSW,W, WNW	4.4 ± 1.3	10 000	3.0
8/23,24/2013	12:00–01:30	0–16	SSW, WSW,W	4.4 ± 2.2	20 000	4.0, 5.0
8/24,25/2013[g]	17:30–01:00	0–16	Calm, SSW, SW, WSW,W, ESE	3.1 ± 2.1	15 000	6.0
11/1/2013	16:00–19:50	0–12	SSE, W, WSW	3.7 ± 0.7	10 000	3.8[e]
12/3/2013	19:45–00:20	0–12	WSW, W, WNW	8.8 ± 1.4	5000	6.0
12/5/2013	13:00–18:30	0–12	WSW, W, WNW	5.5 ± 0.6	10 000	2.8
12/9/2013	16:00–00:00	0–10	N, NNE	2.7 ± 0.6	20 000	n/a
12/10/2013	15:30–21:30	0–10	WNW,N, NW	3.1 ± 1.1	20 000	5.0
12/14/2013	17:00–20:30	0–10	W, Calm	2.1 ± 0.5	20 000	data lost
12/15,16/2013	22:00–02:00	0–10	N, NE, ESE	2.9 ± 1.0	17 500	n/a
12/16/2013	10:00–16:00	0–12	N, W	2.8 ± 1.6	10 000	4.5
12/18/2013	17:30–20:30	0–10	WSW, SSW, SSE	3.3 ± 1.3	10 000	6.0
12/20/2013	16:30–20:00	0–10	WSW, Calm, E	2.6 ± 1.3	15 000	4.0
12/23/2013	15:15–19:00	0–12	W, Calm, E	2.8 ± 1.3	10 000	11.0

[a]The runs for which maps are presented are formatted in bold. [b]Predominant wind direction is formatted as bold. [c]Urban background value concentrations are reported to nearest 2500 particles/cm^3 and are the average baseline values in the unimpacted areas away from local traffic sources [d]Concurrent MMP sampling times: June 22:1320–1720, June 27:1325–1510, July 1:1240–1640. [e]Monitoring route did not cover the full N–S extent of the impact on Western Av (10 km downwind) on these days, values have been reported for Crenshaw Blvd. (8 km downwind). [f]Easterly flow was recorded in morning hours (until 1000) and westerly later morning to afternoon [g]08/25/2013 was not counted as an additional monitoring day because only 1 h of monitoring (0000–0100) was conducted on this date

h in the winter (1200–1800 in December). Only during the winter months (November–February, 0000–0900) are light easterly off-shore winds common.[12] Wind speed and direction during the monitoring periods are summarized in Table 1. Wind roses based on 1 min data are shown in Figure S.2 and S.3 of the SI.

Data Processing. MMP measurements included a localized traffic emissions signal representing microscale and middle scale variations (10–100 m and 100–500 m, respectively) and an underlying "baseline" pollutant concentration that varied gradually over the neighborhood scale (500 m–4 km).[13] Watson et al. 1997[13] derived these categories by considering the spatial scales of impact of various types of air pollution sources. We adopted a smoothing methodology to estimate baseline PN concentrations that excluded the microscale and middle scale impacts due to local sources, usually specific vehicles.

Baseline PN concentrations were derived from our mobile measurements by taking a rolling 30-s fifth percentile value of the 1-s concentration time series, and assigning that value to the measured location. This removed the microscale and middle scale impacts from traffic sources such as specific vehicle plumes. Baseline concentrations for a run were relatively spatially uniform outside of the LAX impact areas, with coefficients of variation (CV) of less than 5%. In comparison, the raw PN concentrations on roadways outside the LAX impact areas had CVs on the order of 40%. On rare occasions, the MMP was behind a high emitter for longer than 30 s. Such events, only if verifiable by video and field notes, were censored. However, less than 0.5% of data were censored in this manner, generated from about a dozen instances of prolonged influence from high emitting vehicles. An illustration of both raw and smoothed concentration time series is presented in the SI (Figures S.4–S.7). The figures in this text are based on smoothed data.

RESULTS AND DISCUSSION

Spatial Pattern and Extent of Elevated PN Concentrations. Downwind of LAX we observed gradual but large increases in baseline PN concentrations occurring over transect distances of multiple kilometers. PN concentrations were elevated 4-fold or more above nearby unimpacted baseline concentrations up to 10 km in the downwind direction from

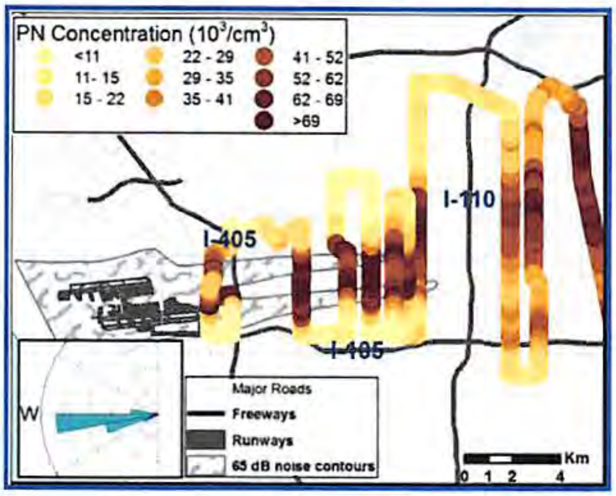


Figure 2. Spatial pattern of PN concentration (colored by deciles) for the afternoon and evening hours of August 23, 2013.

LAX. Figure 2 shows an example of the spatial pattern of the elevated PN concentrations.

The size of the impacted areas with high PN concentration increases was remarkable. At 16 km downwind, a 2-fold increase in PN concentration over baseline concentrations was measured across 6.5 km. Assuming a trapezoidal shaped plume with parallel edges of length 1.5 and 6.5 km, PN concentrations were at least doubled over an area of 60 km^2. Eight km downwind, a 5-fold increase in PN concentrations over baseline concentrations extended across 3 km and covered a total area of 24 km^2. (Concentrations in this large area exceeded 71 000 particles/cm^3, the average concentration on Los Angeles freeways.[14]) Within 3 km of the airport boundary, concentrations were elevated nearly 10-fold, exceeding 100 000 particles/cm^3, with concentrations of 150 000 particles/cm^3 occurring over a several km^2 area.

This pattern of elevated PN concentrations over large areas east of LAX was consistently observed during periods when there were both westerly winds and high air traffic volumes, typically all daylight hours and well into the night. Figure 3

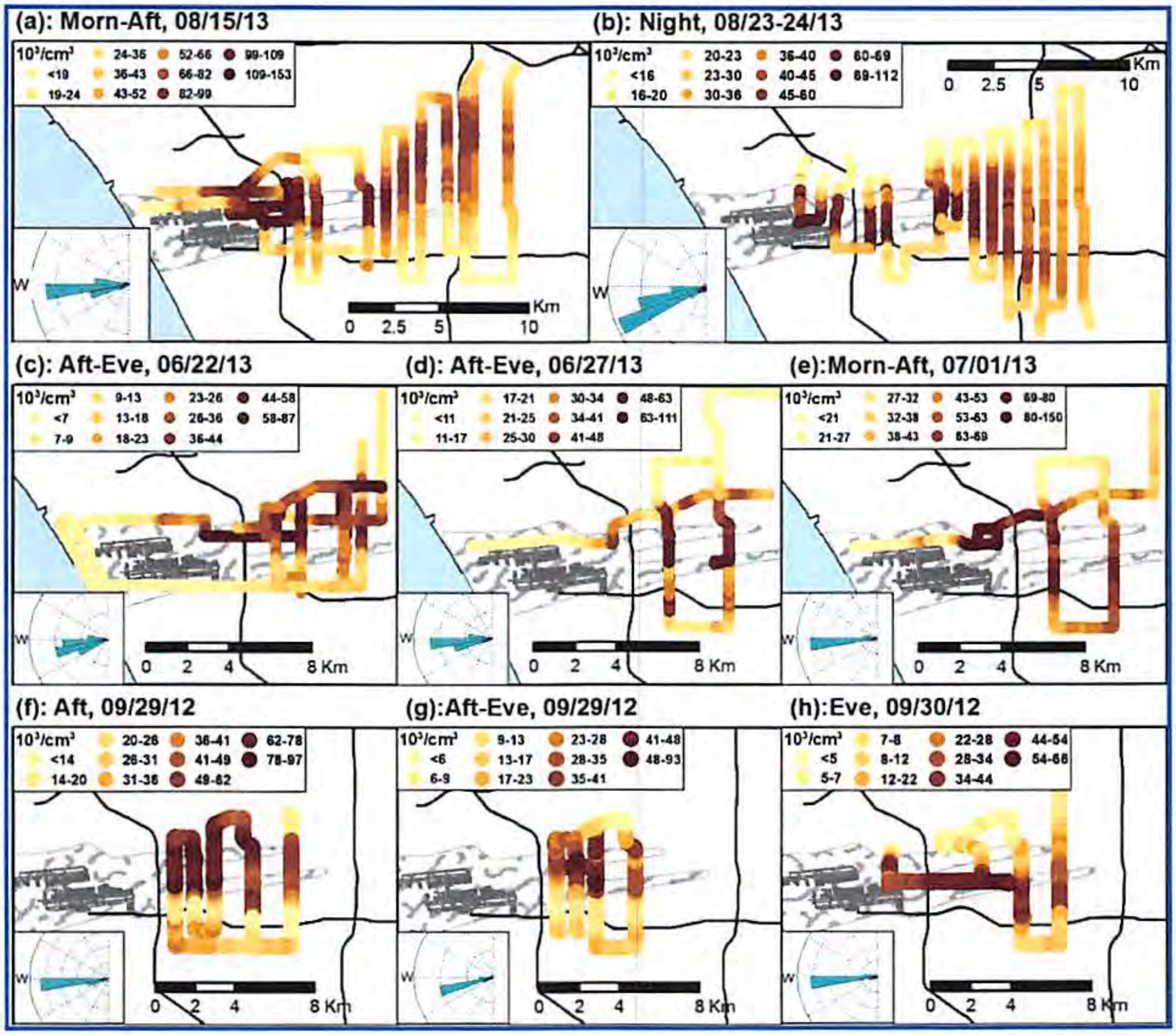


Figure 3. Spatial pattern of impact during different monitoring events. Wind direction during monitoring is shown in insets on bottom left. PN concentrations are classified and colored by deciles.

dx.doi.org/10.1021/es5001566 | Environ. Sci. Technol. 2014, 48, 6628−6635

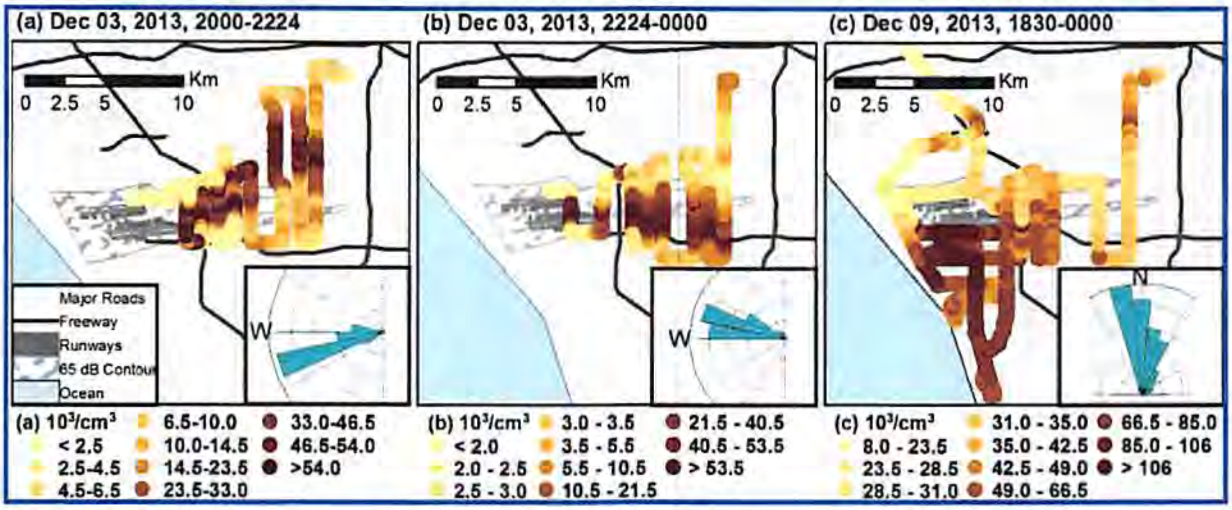


Figure 4. Change in location of impact due to shift in wind direction. Wind direction during monitoring is shown in insets on bottom left. PN concentrations are classified and colored by deciles.

shows the consistency of the patterns over eight monitoring runs at various times of day, displayed in each row by similarity of spatial scale.

In directions other than the downwind direction, no large areas of elevated PN concentrations were observed. Figures 3(c)−(e) include concentrations measured upwind of the LAX boundary (these are indicated by faint yellow lines within the noise contour); the concentrations recorded were typical of the coastal baseline concentrations, less than 10 000 particles per cm^3 (also see Figure S.8 in SI). Of possible other PN sources, a large refinery is located south of the airport but we did not observe elevated PN or other pollutant concentrations directly downwind of this source. In general, industrial point sources of pollution in the Los Angeles Air Basin are very tightly regulated by the South Coast Air Quality Management District.

We did not observe distinct day versus night differences, as might be expected based on the large change in meteorologically driven dilution between day and night for ground level sources. It appeared that the distant impacts we observed downwind of LAX required sufficient wind speeds for the jet climbing and landing emissions to reach the ground, as observed in Yu et al., 2004[2] at LAX and Hong Kong International Airports and Carslaw et al. 2006[1] at Heathrow Airport. At LAX, this probably corresponded to the development of the on-shore sea breezes that typically started 4−6 h after sunrise and lasted until 3−6 h after sunset.[12]

We also did not see the impacts of individual jets at the distances monitored, but the merging of individual jet impacts is not unexpected at distances of multiple km. Considering the frequency of landings and takeoffs (>90 per hour from 0900−2100[10]), at an average wind speed of 4 m/s, for example, an incoming parcel of air will travel only about 160 m before another jet landing or takeoff occurs. Under normal daytime air turbulence and the enhanced turbulence produced by jets,[15,16] significant mixing is expected over a 5−10 km distance (20−40 min). The generally smooth increases and decreases observed across the length of transects at such distances are additional evidence that mixing of plumes occurs. Examples of these smooth concentration increases for individual transects are shown in Figures S.6 and S.7 in the SI.

The consistent and distinctive spatial pattern of elevated concentrations was aligned to prevailing westerly winds and landing jet trajectories, and roughly followed the shape of the contours of noise from landing jets, indicating that landing jets probably are an important contributor to the large downwind spatial extent of elevated PN concentrations. As defined by the International Civil Aviation Organization, typical engine thrust during landing is 30%, as compared to 100% for takeoff and 85% for the climbing phase.[6] Stettler et al. 2011[6] calculated 18% of total NO_x emissions from landings, with 12% from taxiing and holding, 18% from takeoff, and 52% from the climb and climb out phases, respectively. When the extra upwind distance of the climb and climb out phases are taken into account, the landing approach emissions likely produce a significant fraction of the increased PN concentrations observed downwind.

Influence of Wind Direction on Location of Impact. The downwind location of the impact changed with shifts in the prevailing wind direction, although significant shifts in wind direction during the daytime are not typical of this area of Los Angeles.[12] Figure 4(a) and (b) illustrate one such change in impacted locations due to a shift in wind direction on a gusty day with frontal weather that also resulted in cleaner upwind baseline PN concentrations of less than 5000 particles/cm^3. The impacted locations were aligned along the NE direction during 2000−2220 h when winds were from W to WSW (250−280°). The impact then moved southwards between 2220−0000 h as winds turned more W to WNW (280−330°). During this shift, the impact centerline moved by 5.5 km on transects 8−10 km east of LAX.

Monitoring was also conducted during N to NE prevailing winds that tend to occur late at night in November and December (2100−2300).[12] This N to NE wind direction resulted in impacts that were centered south of the airport (Figure 4(c)). The PN concentrations in this southerly impact were roughly twice as high as on other days, in part because the baseline PN concentrations reflected urban air from northerly winds instead of marine air from westerly winds.

Diurnal wind patterns change little by season in Los Angeles basin.[12] Onshore westerly winds are common during midday hours, even in winter. As a result, areas of elevated PN

dx.doi.org/10.1021/es5001566 | Environ. Sci. Technol. 2014, 48, 6628−6635

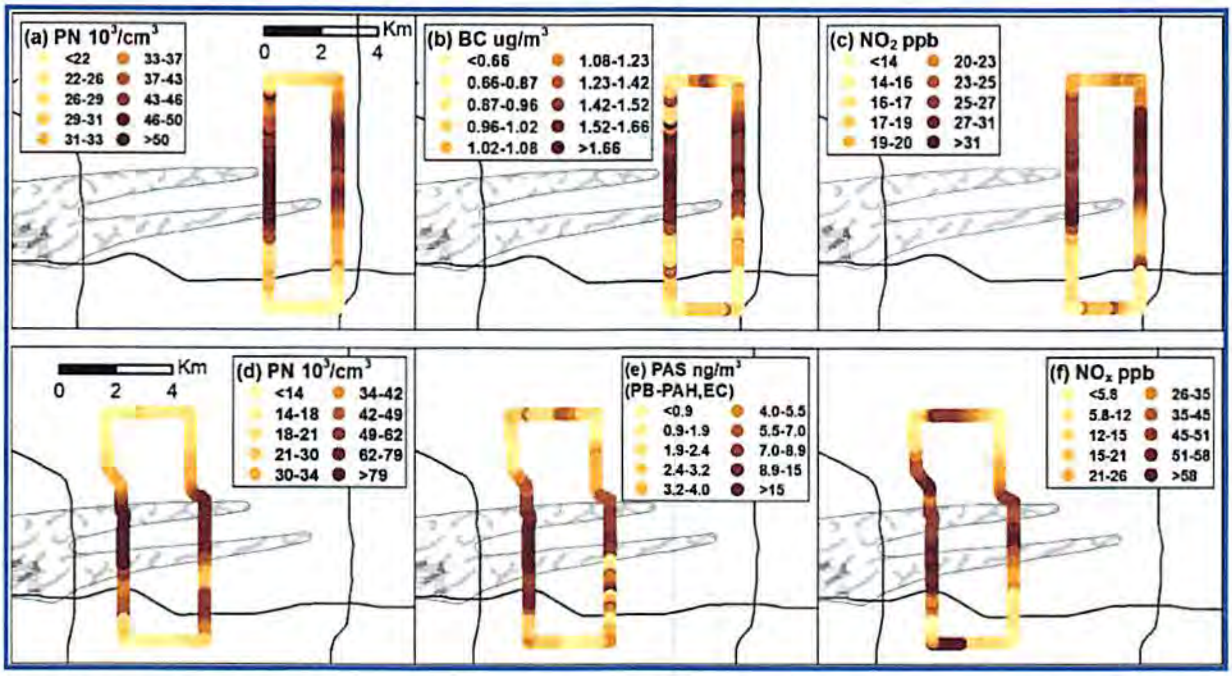


Figure 5. Spatial pattern of simultaneously measured pollutants during 1400−1530 on June 27, 2013. Concentrations are classified and colored by deciles. Panels (a)−(c) show data measured by the UW MMP and (d)−(f) show data measured by the USC MMP.

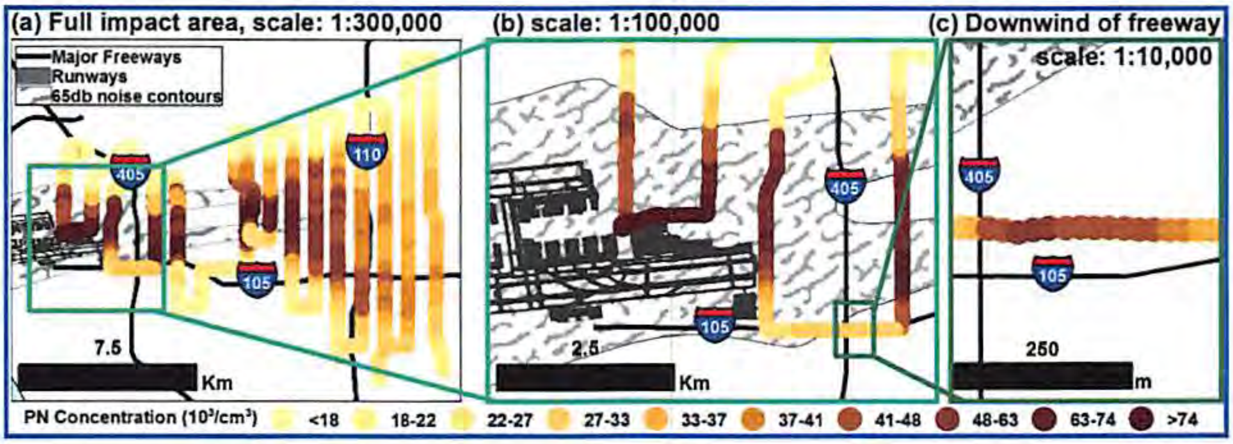


Figure 6. Comparison of the spatial scale of freeway impacts compared to airport impacts for monitoring during nighttime on August 23−24, 2013.

concentrations downwind and east of LAX likely occur in all seasons. Monitoring in different seasons demonstrated the consistent year round presence of this impact. Examples of similarly extensive impacts in non-summer months are shown in the SI (Figures S.8 and S.9).

Other Pollutants. Over large areas downwind of LAX, concentrations of pollutants other than PN were also elevated. Figure 5(a)−(c) show nearly indistinguishable spatial patterns for PN, BC, and NO_2 concentration measured simultaneously at distances of 9.5−12 km from LAX. This suggests a common source for these pollutants, although the BC concentration increases were not large when compared to PN and NO_x, about 0.5−1 $\mu g/m^3$ at 8−10 km downwind. While jet aircraft are not known to produce large amounts of BC, two studies found elevated BC from plane takeoffs at LAX. Zhu et al. 2011[9] measured an increase of about 1 $\mu g/m^3$ of BC due to plane activity 140 m downwind of the runway. Westerdahl et al. 2008[8] measured increases in BC concentration of several $\mu g/m^3$ during takeoff events near the eastern LAX boundary, but also observed elevated BC concentrations at all times. At a smaller airport, Dodson et al. 2009[4] found median contributions of about 0.1 $\mu g/m^3$, about one-quarter of total BC measured at five sites ranging in downwind distance from 0.3−3.7 km, and also observed departures producing about twice the impact as arrivals. Therefore, it appears some jets at LAX are capable of producing measurable increases in BC, particularly at takeoffs.

Spatial patterns of simultaneously measured PN and PAS response (PB−PAH and EC) were also similar on transects 4.5−7.5 km from LAX (Figure 5(d)−(e)). The NO_X elevation pattern was less regular (Figure 5(f)). This was likely due to smaller LAX related contributions compared to baseline concentrations, thus reducing the signal-to-noise ratio.

dx.doi.org/10.1021/es5001566 | Environ. Sci. Technol. 2014, 48, 6628−6635

Overall, the top quartile concentrations (highly impacted) of all pollutants were about three times higher than the lowest quartile within 7.5 km from LAX and two times higher at 12 km distance. In addition, concurrent sampling with the two mobile platforms demonstrated high temporal (SI Figure S.10) and spatial consistency (SI Figure S.11) for PN measurements.

Comparison of LAX and Freeway PN Impacts. PN concentration increases from ground level line sources such as freeways, under conditions of daytime crosswind dilution, decrease exponentially with increasing downwind distance and return to baseline concentrations within 200−300 m.[17] The two N−S freeways (I-405 and I-110 that run perpendicular to the prevailing winds) did not contribute appreciably to elevated PN concentrations in areas where we observed large impacts from LAX on PN concentrations. This is illustrated in Figure 6, which contains two enlargements to show the increase in PN number concentrations over approximately 250 m distance downwind of I-405, a distance and an increase in PN concentration that is not discernible at the scale of Figures 2 and 3. The panel in Figure 6(c) at 1:10 000 scale shows the PN concentration increase of about 24 000/cm^3. The maximum PN concentration was not immediately downwind of the freeway because at this location there is an elevated overpass and some distance is needed for emissions to reach the ground.

To put into further perspective the extent of the elevated PN concentrations observed downwind of LAX, we estimated the freeway length necessary to produce an equivalent impact in terms of PN concentration-weighted area of impact assuming typical daytime dilution conditions for freeways.

For the days we captured the fullest downwind extent of the impact under typical daytime wind conditions (August 15, 23, and 24), we calculated an integrated PN impact above baseline PN concentrations of 2.3, 1.6, and 1.1 × 10^6 (particles/cm^3) × km^2, respectively. See Table S.3(a)−(c) of SI for calculations. Impacted areas were calculated using ArcGIS spatial analysis tools and were conservatively defined as areas where increased PN concentration were at least double the baseline concentrations measured north and south of the impact zone. The resulting impact areas were 30−65 km^2. For comparison, a less conservative criterion for defining the impact area such as a 50% or 33% increase over baseline PN concentrations increased the impacted area by 40% and 80%, respectively.

To calculate PN impacts downwind of freeways, we combined the exponential regression fit of near-freeway measurements made downwind of I-405 by Zhu et al. 2002a[18] with updated average daytime on-freeway PN concentrations taken from Li et al. 2013[14] (71 000 particles/cm^3). PN concentrations were at least double the baseline PN concentrations of 15 000−20 000 particles/cm^3 for 90−130 m downwind.[3] This resulted in a concentration-weighted impact area of 2930−3930 (particles/cm^3) × km^2 per km of freeway length.

Based on these concentration-weighted impact areas, 280−790 km of freeway are needed to produce the equivalent PN-concentration-weighted impact area of LAX. (The less conservative criteria resulted in ranges of freeway length of 340−1000 km and 430−1100 km for thresholds of 50% and 33%, respectively.) There are only about 1500 km of freeways and highways in Los Angeles County.[19] Therefore, LAX should be considered one of the most important sources of PN in Los Angeles. For comparison, within the 60 km^2 area of elevated PN concentrations downwind and east of LAX, the 15−25 km of freeways contributed less than 5% of the PN concentration increase.

Recommendations for Other Studies. LAX is in a region of Los Angeles with highly consistent wind direction. This provided the several hours necessary for a single mobile platform to monitor a sufficient number of transects to cover the large area impacted by LAX emissions. At airport locations where the prevailing wind direction frequently shifts during the day, multiple platforms would be necessary to quickly capture the full spatial extent of emissions impacts to surrounding air quality.

The emissions from LAX are likely not unique on a per-activity basis. The large area of impact from LAX suggests that air pollution studies involving PN, localized roadway impacts, or other sources whose impacts are in the influence zone of a large airport should carefully consider wind conditions and whether measurements are influenced by airport emissions.

Source apportionment of specific airport sources or activities was beyond the scope of our study but would be necessary to evaluate the effectiveness of possible mitigation options. Differing NO_2 to NO_x ratios at different levels of engine thrust[20] might be used to distinguish the contributions of jet landing, idling or takeoff activities. Takeoff and idling emission also differ in surface properties (i.e., the ratio of active surface area to surface bound photoionizable species)[21] and particle size distributions differ between aircraft and ground support equipment emissions.[21]

■ ASSOCIATED CONTENT

Supporting Information

Map of monitoring area (Figure S.1), the instruments used (Tables S.1−S.2), wind roses (Figures S.2 and S.3), illustration of data processing (Figures S.4−S.7), additional maps illustrating the spatial pattern (Figures S.8 and S.9), concurrent sampling with two mobile measurement platforms (Figures S.10 and S.11) and calculations for comparing freeway impact (Table S.3 (a)−(c)) are presented in the Supporting Information. This material is available free of charge via the Internet at http://pubs.acs.org.

■ AUTHOR INFORMATION

Corresponding Author

*Phone: 323-442-2870; fax: 323-442-3272; e-mail: fruin@usc.edu.

Present Address

[‖]S.A.F.: Keck School of Medicine, Department of Preventive Medicine, University of Southern California, 2001 North Soto Street, Los Angeles, CA 90089-9013, United States.

Notes

The authors declare no competing financial interest.

■ ACKNOWLEDGMENTS

This work was funded by National Institute of Environmental Health Sciences (NIEHS) Grant 1K25ES019224-01 and 5P30ES007048 to the University of Southern California and by US EPA Grant RD-83479601-0. This publication's contents are solely the responsibility of the grantee and do not necessarily represent the official views of NIEHS or US EPA. Further, NIEHS and U.S. EPA do not endorse the purchase of any commercial products or services mentioned in the publication. We thank Andrea Hricko of USC for helpful comments.

REFERENCES

(1) Carslaw, D. C.; Beevers, S. D.; Ropkins, K.; Bell, M. C. Detecting and quantifying aircraft and other on-airport contributions to ambient nitrogen oxides in the vicinity of a large international airport. *Atmos. Environ.* 2006, *40* (28), 5424–5434.

(2) Yu, K. N.; Cheung, Y. P.; Cheung, T.; Henry, R. C. Identifying the impact of large urban airports on local air quality by nonparametric regression. *Atmos. Environ.* 2004, *38* (27), 4501–4507.

(3) Fanning, E., Yu, R. C., Lu, R., Froines, J. *Monitoring and Modeling of Ultrafine Particles and Black Carbon at the Los Angeles International Airport*; California Air Resources Board, 2007.

(4) Dodson, R. E.; Houseman, E. A.; Morin, B.; Levy, J. I. An analysis of continuous black carbon concentrations in proximity to an airport and major roadways. *Atmos. Environ.* 2009, *43* (24), 3764–3773.

(5) Klapmeyer, M. E.; Marr, L. C. CO_2, NO_x and particle emissions from aircraft and support activities at a regional airport. *Environ. Sci. Technol.* 2012, *46*, 10974–110981.

(6) Stettler, M. E. J.; Eastham, S.; Barrett, S. R. H. Air quality and public health impacts of UK airports. Part I: Emissions. *Atmos. Environ.* 2011, *45*, 5415–5424.

(7) Hsu, H. H.; Adamkiewicz, G.; Houseman, E. A.; Zarubiak, D.; Spengler, J. D.; Levy, J. I. Contributions of aircraft arrivals and departures to ultrafine particle counts near Los Angeles International Airport. *Sci. Total Environ.* 2013, *444*, 347–355.

(8) Westerdahl, D.; Fruin, S. A.; Fine, P. M.; Sioutas, C. The Los Angeles International Airport as a source of ultrafine particles and other pollutants to nearby communities. *Atmos. Environ.* 2008, *42*, 3143–55.

(9) Zhu, Y.; Fanning, E.; Yu, R. C.; Zhang, Q.; Froines, J. R. Aircraft emissions and local air quality impacts from takeoff activities at a large international airport. *Atmos. Environ.* 2011, *45*, 6526–33.

(10) California State Airport Noise Standards Quarterly Report, First Quarter, Los Angeles World Airports, September 18, 2013. http://www.lawa.org/welcome_lax.aspx?id=1090 (accessed December 03, 2013).

(11) Los Angeles County Regional Planning Department, Airport Land Use Commission, DRP_Airport_Influence_Areas. http://egis3.lacounty.gov/dataportal/2011/02/09/airport-influence-areas/ (accessed April 19, 2014).

(12) Fisk, C. J. *Diurnal and Seasonal Wind Variability for Selected Stations in Southern California Climate Regions*, 20th Conference on Climate Variability and Change; American Meteorological Society: New Orleans, January 20–24, 2008; http://ams.confex.com/ams/pdfpapers/135164.pdf (accessed November 11, 2013).

(13) Watson, J. G.; Chow, J. C.; DuBois, D. W.; Green, M. C.; Frank, N. H.; Pitchford, M. L. *Guidance for Network Design and Optimal Site Exposure for $PM_{2.5}$ and PM_{10}*, Report No. EPA-454/R-99-022; *U.S. Environmental Protection Agency*, Research Triangle Park, NC. 1997.

(14) Li, L.; Wu, J.; Hudda, N.; Sioutas, C.; Fruin, S. A.; Delfino, R. J. Modeling the concentrations of on-road air pollutants in southern California. *Environ. Sci. Technol.* 2013, *47* (16), 9291–9299.

(15) Graham, A.; Raper, D. W. Transport to ground of emissions in aircraft wakes. Part I: Processes. *Atmos. Environ.* 2006, *40*, 5874–85.

(16) Graham, A.; Raper, D. W. Transport to ground of emissions in aircraft wakes. Part II: Effect on NO_x concentrations in airport approaches. *Atmos. Environ.* 2006, *40*, 5824–36.

(17) Karner, A.; Eisinger, A.; Niemeier, D. Near-roadway air quality: Synthesizing the findings from real-world data. *Environ. Sci. Technol.* 2010, *44*, 5334–5344.

(18) Zhu, Y.; Hinds, W. C.; Kim, S.; Shen, S.; Sioutas, C. Concentration and size distribution of ultrafine particles near a major highway. *J. Air Waste Manage. Assoc.* 2002a, *36* (27), 4323–4335.

(19) California Department of Transportation. http://www.dot.ca.gov/dist07/aboutus/profile/d7p_print.html (accessed November 11, 2013).

(20) Herndon, S. C.; Shorter, J. H.; Zahniser, M. S.; Nelson, D. D. J.; Jayne, J. T.; Brown, R. C.; Miake-Lye, R. C.; Waitz, I. A.; Silva, P.; Lanni, T.; Demerjian, K. L.; Kolb, C. E. NO and NO_2 emissions ratios measured from in use commercial aircraft during taxi and take-off. *Environ. Sci. Technol.* 2004, *38*, 6078–84.

(21) Herndon, S. C.; Onasch, T. B.; Frank, B. P.; Marr, L. C.; Jayne, J. T.; Canagaratna, M. R.; Grygas, J.; Lanni, T.; Anderson, B. E.; Worsnop, D.; Miake-Lye, R. C. Particulate emissions from in-use commercial aircraft. *Aerosol Sci. Technol.* 2005, *39* (8), 799–809, DOI: 10.1080/02786820500247363.

Noise & Health
A Bimonthly Inter-disciplinary International Journal

CURRENT ISSUE | PAST ISSUES | AHEAD OF PRINT | SEARCH | GET E-ALERTS

Similar in PUBMED
Search Pubmed for

- Basner M
- Clark C
- Hansell A
- Hileman JI
- Janssen S
- Shepherd K
- Sparrow V

Search in Google Scholar for

- Basner M
- Clark C
- Hansell A
- Hileman JI
- Janssen S
- Shepherd K
- Sparrow V

Related articles

- Aircraft
- annoyance
- health
- noise
- performance
- sleep

Email Alert *
Add to My List *
* Registration required (free)

Previous Article | ToC | Next Article

REVIEW ARTICLE

Year : 2017 | **Volume** : 19 | **Issue** : 87 | **Page** : 41-50

Aviation Noise Impacts: State of the Science

Mathias Basner[1], Charlotte Clark[2], Anna Hansell[3], James I Hileman[4], Sabine Janssen[5], Kevin Shepherd[6], Victor Sparrow[7]

[1] Unit for Experimental Psychiatry, Division of Sleep and Chronobiology, University of Pennsylvania Perelman School of Medicine, Philadelphia, PA, USA

[2] Centre for Psychiatry, Barts & The London School of Medicine, Queen Mary University of London, London, United Kingdom

[3] MRC-PHE Centre for Environment and Health, Department of Epidemiology and Biostatistics, School of Public Health, Faculty of Medicine, Imperial College London; Public Health and Primary Care, Imperial College Healthcare NHS Trust, St. Mary's Hospital, London, United Kingdom

[4] Office of Environment and Energy (AEE-3), Federal Aviation Administration, Washington, DC, USA

[5] Urban Environment and Safety, TNO (Netherlands Organization for Applied Scientific Research), Delft, The Netherlands

[6] M.S. 463 Structural Acoustics Branch, NASA Langley Research Center, Hampton, VA, USA

[7] Penn State, University Park, PA, USA

Click here for **correspondence address** and email

Date of Web Publication 17-Apr-2017

Download Article (pdf) | Email Article | Print Article | Read / Write a Comment | Citation Manager

Abstract

Noise is defined as "unwanted sound." Aircraft noise is one, if not the most detrimental environmental effect of aviation. It can cause community annoyance, disrupt sleep, adversely affect academic performance of children, and could increase the risk for cardiovascular disease of people living in the vicinity of airports. In some airports, noise constrains air traffic growth. This consensus paper was prepared by the Impacts of Science Group of the Committee for Aviation Environmental Protection of the International Civil Aviation Organization and summarizes the state of the science of noise effects research in the areas of noise measurement and prediction, community annoyance, children's learning, sleep disturbance, and health. It also briefly discusses civilian supersonic aircraft as a future source of aviation noise.

Keywords: Aircraft, annoyance, health, noise, performance, sleep

How to cite this article:
Basner M, Clark C, Hansell A, Hileman JI, Janssen S, Shepherd K, Sparrow V. Aviation Noise Impacts: State of the Science. Noise Health 2017;19:41-50

How to cite this URL:

Comments [Add]

Basner M, Clark C, Hansell A, Hileman JI, Janssen S, Shepherd K, Sparrow V. Aviation Noise Impacts: State of the Science. Noise Health [serial online] 2017 [cited 2018 Jul 23];19:41-50. Available from: http://www.noiseandhealth.org/text.asp?2017/19/87/41/204623

Introduction

Purpose

The goal of this review is to briefly summarize the current state of scientific knowledge regarding the adverse effects of aircraft noise emissions on the public. Every effort has been made to base the findings upon peer-reviewed publications, carefully reviewed by specialists from around the world. The topics addressed here are community annoyance, children's learning, sleep disturbance, health impacts, and the noise of supersonic aircraft. Appendix A [Additional file 1] additionally provides some background information on noise measurement and prediction as well as technical definitions for the interested reader.

Task of the panel

Aircraft noise discussions can be very emotional, and politicians and legislators often struggle to define limit values that both protect the population against the adverse effects of aircraft noise but do not restrict the positive societal effects of air traffic. Noise effects researchers have an important advisory role. They derive so-called exposure–response functions that allow health impact assessments and, therefore, inform political decision-making. The efforts of the Noise Panel were directed at assessing the current state of the science and provide contracting states with a brief overview of the impacts of aircraft noise on communities. This white paper constitutes a consensus among its authors, who have considerable experience in noise effects research, and is based on input from an international expert panel workshop held on February 10 and 11, 2015 in Alexandria, VA, USA. Noise effects depend, among others, on housing structure and cultural values, and legislation and limit values accordingly differ considerably between contracting states. Therefore, the authors did not try to suggest specific limit values, but rather pointed to existing exposure–response functions and recommendations of international organizations.

Community Annoyance

Definition of community annoyance

Community annoyance refers to the average evaluation of the disturbing aspects or nuisance of a noise situation by a "community" or group of residents, combined in a single outcome, annoyance. To facilitate inter-study comparisons and data pooling for the development of exposure–response relationships, a standardized annoyance question has been proposed by members of the International Commission on Biological Effects of Noise,[1] and was adopted by ISO TS 15666.[2] The percentage of highly annoyed respondents is considered to be the main indicator of community annoyance. The use of a common question allows for the comparison of studies from around the globe. As such, the Impacts of Science Group (ISG) encourages states to utilize the ISO TS 15666 survey in their efforts to measure and understand community annoyance.

Moderating non-acoustic variables

Individual annoyance scores are not only related to acoustic variables, but can be importantly moderated by several personal and situational variables. Two meta-analyses on the influence of such non-acoustical factors on annoyance showed the largest effects of age, fear, and noise sensitivity.[3],[4] Additional moderating variables put forward are beliefs on the necessity of the noise source, the ability to somehow control or cope with noise or its consequences, trust in authorities, and previous experience with or future expectations regarding noise.[5],[6]

Exposure–response relationships

Over the years, several attempts have been made to relate the percentage of respondents highly annoyed by a given source to the day–night average noise exposure level L_{DN}. The derivation of exposure–response curves based on data from many individual studies[7] yielded different curves for aircraft, road traffic, and railway noise, with higher annoyance for aircraft noise than for road traffic or railway noise at the same exposure level. However, there is evidence that the annoyance response to aircraft noise has even increased over the years, and that exposure–response curves based on older aircraft noise annoyance data may no longer apply.[8],[9] This stresses the need for an update based on more recent studies using standardized methods.

(Inter)national versus local exposure–response relationships

While exposure–response relationships have been recommended for assessing the expected annoyance response in noise situations, they are not applicable to assess the short-term effects of a change in noise climate. There are indications for a temporary overshoot in annoyance response in situations with a high rate of change, for instance, where a new runway is opened.[10],[11] In addition, in more or less steady state situations, the annoyance response in specific surveys often differs from the average expected response.[12] Since airports and communities may differ greatly in several variables moderating annoyance, local exposure–response relationships, if available, may be preferred for predicting annoyance. Still, exposure–response relationships describing the average annoyance response are required to allow health impact assessment across communities and to establish preferable limit values for levels of aircraft noise.

Complaints and their relationship to noise and noise effects

Many airports receive and log complaints as a part of their noise monitoring and community outreach efforts. Complaints seem to be triggered by unusual events (e.g., louder than normal; unusual aircraft ground track or altitude) and operational changes (changes in runway usage or flight tracks). Annoyance and complaints are different phenomena, the first being a privately held opinion, and the latter being an overt action. Relatively few studies have utilized complaints databases to investigate whether complaints are related to long-term annoyance as measured using social surveys. Rather than monitoring the number of callers, which may be distorted by repeat callers, this approach should preferably be based on the number of individual complainants and the number of specific issues or incidents that cause complaints. There is, however, evidence to suggest that complainants do not represent a cross-section of the population at large, both in terms of their demographic characteristics and their annoyance.

Supplementary noise metrics

An important question for aircraft noise annoyance is whether the annoyance due to infrequent high levels of noise events is the same as the annoyance caused by frequent moderate levels at the same L_{DN}. While some data suggest that the trade-off between levels and numbers of overflights in L_{Aeq}-based metrics such as L_{DN} is approximately correct for predicting the noise annoyance,[13] there are also data suggesting that a higher weight of the number of flights might be appropriate.[14] However, an examination of 10+ airport surveys did not support a weighting of "number" greater than that implicit in L_{Aeq}.[15] On average, the weighting was less than that.

Noise mitigation

Annoyance due to aircraft noise has been recognized by authorities and policy makers as a harmful effect that should be prevented and reduced. Priority is given to noise reduction at the source (e.g., engine noise, aerodynamic noise) and reducing noise by adjusting take-off and landing procedures, but these measures are not always sufficient or feasible. Sound insulation of dwellings is often applied, but may not reduce annoyance levels when it is associated with poor indoor air quality.[16] In addition, the observed influence on annoyance of several non-acoustical factors such as fear, perceived control, and trust in authorities suggests that communication strategies addressing these issues could strongly contribute to the reduction of annoyance, alongside or even in the absence of a noise reduction.

Conclusions

There is substantial evidence that aircraft noise exposure is associated with annoyance indicators, and exposure–response relationships have been derived to estimate the expected percentage of highly annoyed persons at a community level. Still, several personal and situational factors importantly affect the annoyance of individuals. Recent evidence for an increase in the annoyance response at a given exposure level indicates the need for updating exposure–response curves based on recent studies using harmonized methods, as well as verifying the circumstances leading to a heightened community response. This could inform political decision-making on managing aircraft noise exposure and on mitigation measures.

Children's Learning

Chronic aircraft noise exposure and children's learning

Recent reviews of how noise, and in particular aircraft noise, affect children's learning have concluded that aircraft noise exposure at school or at home is associated with children having poorer reading and memory skills.[17] There is also an increasing evidence base which suggests that children exposed to chronic aircraft noise at school have poorer performance on standardized achievement tests, compared with children who are not exposed to aircraft noise. In the limited space available here, it is only possible to discuss some of the central epidemiological field studies forming the empirical basis of these conclusions. The most recent large scale cross-sectional study, the RANCH study (Road traffic and Aircraft Noise and children's Cognition & Health), of 2844

children aged 9–10 years from 89 schools around London Heathrow, Amsterdam Schiphol, and Madrid Barajas airports found exposure–response associations between aircraft noise and poorer reading comprehension and poorer recognition memory, after taking social position and road traffic noise, into account.[18] Reading comprehension began to fall below average at around 55 dB $L_{Aeq,16hours}$ at school, but as the association was linear, there is no specific threshold above which noise effects begin, and any reduction in aircraft noise exposure should lead to an improvement in reading comprehension. A 5 dB increase in aircraft noise exposure was associated with a 2 month delay in reading age in the UK, and a 1-month delay in the Netherlands.[19] These associations were not explained by air pollution.[20] Children's aircraft noise exposure at school and that at home are often highly correlated. In the RANCH study, night-time aircraft noise at the child's home was also associated with impaired reading comprehension and recognition memory, but night-noise did not have an additional effect to that of daytime noise exposure on reading comprehension or recognition memory.[21]

Interventions to reduce aircraft noise exposure at school

Studies have shown that interventions to reduce aircraft noise exposure at school do improve children's learning outcomes. The longitudinal, prospective Munich Airport study[22] found that prior to the relocation of the airport in Munich, high noise exposure was associated with poorer long-term memory and reading comprehension in children aged 10 years. Two years after the airport was closed, these cognitive impairments were no longer present, suggesting that the effects of aircraft noise on cognitive performance may be reversible if the noise stops. In the cohort of children living near the newly opened Munich airport, impairments in memory and reading developed over the 2-year period. This study suggests that it takes a couple of years for impairments to develop. A cross-sectional study of 6000 schools exposed between the years 2000–2009 at the top 46 United States airports (exposed to day–night-average sound level of 55 dB or higher) found significant associations between aircraft noise and standardized tests of mathematics and reading, after taking demographic and school factors into account.[23] In a sub-sample of 119 schools, it was found that the effect of aircraft noise on children's learning disappeared once the school had sound insulation installed. These studies suggest that insulation of schools yields improvements in children's learning.

Mechanisms linking chronic aircraft noise exposure and learning

Aircraft noise may directly affect the development of cognitive skills such as reading and memory, but a range of pathways and mechanisms for the effects have also been proposed. Effects might be accounted for by communication difficulties, teacher and pupil frustration, reduced morale, impaired attention, increased arousal – which influences task performance, and sleep disturbance from home exposure which might cause performance effects the next day.[24],[25] Noise causes annoyance, particularly if an individual feels their activities are being disturbed or if it causes difficulties with communication. In some individuals, annoyance responses may result in physiological and psychological stress responses, which might explain poorer learning outcomes.

Guidelines for children's noise exposure at school

The World Health Organization (WHO) Community Noise Guidelines[26] suggest that the background sound pressure level (SPL) in school classrooms should not exceed 35 dB L_{Aeq} during teaching sessions to protect from speech intelligibility and disturbance of information extraction. The WHO guidelines also suggest that school's outdoor playgrounds should not exceed 55 dB L_{Aeq} during the recess period, to protect from annoyance. The American National Standards Institute (ANSI) Standard for School Acoustics (ANSI S12.50-2002/2010), suggests that internal background noise for unoccupied classrooms should be 35 dB L_{Aeq}. The ANSI standard is supported by the Acoustical Society of America and INCE-USA. While the WHO and the ANSI guidelines both specify a maximum sound level of 35 dB for classrooms, it should be noted that for ANSI guidelines, this is for unoccupied classrooms, whereas for the WHO guidelines, this is for occupied classrooms. It should also be noted that WHO included cognitive impairment of children as one end-point in their publication on *Burden of Disease from Environmental Noise – Quantification of healthy life years lost in Europe*,[27] relying mainly on the results from the Munich study and the RANCH study.

Conclusions

There is sufficient evidence for a negative effect of aircraft noise exposure on children's cognitive skills such as reading and memory, as well as on standardized academic test scores. Evidence is also emerging to support the insulation of schools that may be exposed to high levels of aircraft noise. A range of plausible mechanisms have been proposed to account for aircraft noise effects on children's learning. Further knowledge about exposure–effect relationships in different contexts would further inform decision-making. It may also be informative to derive relationships for a range of additional noise exposure metrics, such as the number of noise events. To date, few studies have evaluated the effects of persistent aircraft noise exposure throughout the child's education, and there remains a need for longitudinal studies of aircraft noise exposure at school and educational outcomes.

Sleep and its importance for health

Sleep is a biological imperative, and a very active process that serves several vital functions. Undisturbed sleep of sufficient length is essential for daytime alertness and performance, quality of life, and health.[27],[28] The epidemiologic evidence that chronically disturbed or curtailed sleep is associated with negative health outcomes (such as obesity, diabetes, and high blood pressure) is overwhelming. For these reasons, noise-induced sleep disturbance is considered the most deleterious non-auditory effect of environmental noise exposure.

Aircraft noise effects on sleep

The auditory system has a watchman function and constantly scans the environment for potential threats. Humans perceive, evaluate, and react to environmental sounds while asleep.[29] At the same SPL, meaningful or potentially harmful noise events are more likely to cause arousals from sleep than less meaningful events. As aircraft noise is intermittent noise, its effects on sleep are primarily determined by the number and acoustical properties (e.g., maximum SPL, spectral composition) of single noise events. However, whether or not noise will disturb sleep also depends on situational (e.g., sleep depth)[30] and individual (e.g., noise sensitivity) moderators.[29] Sensitivity to nocturnal noise exposure varies considerably between individuals. The elderly, children, shift-workers, and those who are ill are considered at risk for noise-induced sleep disturbance.[28] Repeated noise-induced arousals impair sleep quality through changes in sleep structure including delayed sleep onset and early awakenings, less deep (slow wave) and rapid eye movement (REM) sleep, and more time spent awake and in superficial sleep stages.[30],[31] Both deep and REM sleep have been shown to be important for sleep recuperation in general and memory consolidation specifically. Non-acoustic factors (e.g., high temperature, nightmares) can also disturb sleep and complicate the unequivocal attribution of arousals to noise.[32] Field studies in the vicinity of airports have shown that most arousals cannot be attributed to aircraft noise, and noise-induced sleep-disturbance is in general less severe than that observed in clinical sleep disorders such as obstructive sleep apnea.[33] Short-term effects of noise-induced sleep disturbance include impaired mood, subjectively and objectively increased daytime sleepiness, and impaired cognitive performance.[34],[35] It is hypothesized that noise-induced sleep disturbance contributes to the increased risk of cardiovascular disease (CVD) if individuals are exposed to relevant noise levels over months and years. Recent epidemiologic studies indicate that nocturnal noise exposure may be more relevant for long-term health consequences than daytime noise exposure, probably because people are also at home more consistently during the night.[36]

Noise effects assessment

Exposure–response functions relating a noise indicator (e.g., maximum SPL) to a sleep outcome (e.g., awakening probability) can be used for health impact assessments and inform political decision-making. Subjects exposed to noise typically habituate, and exposure–response functions derived in the field (where subjects have often been exposed to the noise for many years) are much shallower than those derived in unfamiliar laboratory settings.[37],[38] Unfortunately, sample sizes and response rates of the studies that are the basis for exposure–response relationships were usually low, which restricts generalizability. Exposure–response functions are typically sigmoidal (s-shaped) and show monotonically increasing effects. Maximum SPLs as low as 33 dB(A) induce physiological reactions during sleep, that is, once the organism is able to differentiate a noise event from the background, physiologic reactions can be expected (albeit with a low probability at low noise levels).[37] This reaction threshold should not be confused with limit values used in legislative and policy settings, which are usually considerably higher. At the same maximum SPL, aircraft noise has been shown to be less likely to disturb sleep compared to road and rail traffic noise, which was partly explained by the frequency distribution, duration, and rise time of the noise events.[31],[39] Although equivalent noise levels are correlated with sleep disturbance, there is general agreement that the number and acoustical properties of noise events better reflect the degree of sleep disturbance (especially for intermitted aircraft noise). As exposure–response functions are typically without a clearly discernible sudden increase in sleep disturbance at a specific noise level, defining limit values is not straight forward and remains a political decision weighing the negative consequences of aircraft noise on sleep with the societal benefits of air traffic. Accordingly, nighttime noise legislation differs between contracting states.

Noise mitigation

Mitigating the effects of aircraft noise on sleep is a three-tiered approach. Noise reduction at the source has highest priority. However, as it will take years for new aircraft with reduced noise emissions to penetrate the market (and will thus not solve the problem in the foreseeable future), additional immediate measures are needed. For example, noise-reducing take-off and landing procedures can often be more easily implemented during the low-traffic nighttime. Land-use planning can be used to reduce the number of relevantly exposed subjects. Passive sound insulation (including ventilation) represent mitigation measures that can be effective in reducing sleep disturbance, as subjects usually spend their nights indoors. At some airports nocturnal traffic curfews have been

imposed by regulation. They can be very effective, but are also a drastic measure and, according to International Civil Aviation Organization's (ICAO) Balanced Approach, should only be implemented as a last resort. It is important to line up the curfew period with the (internationally varying) sleep patterns of the population.

Conclusions

Undisturbed sleep is a prerequisite for high daytime performance, well-being and health. Aircraft noise can disturb sleep and impair sleep recuperation. Further research is needed to (a) derive reliable exposure–response relationships between aircraft noise exposure and sleep disturbance, (b) explore the link between noise-induced sleep disturbance and long-term health consequences, (c) investigate vulnerable populations, and (d) demonstrate the effectiveness of noise mitigation strategies. This research will inform political decision-making and help mitigate the effects of aircraft noise on sleep.

Health Impacts

There are several ways in which noise could affect health,[40] including a physiological response via the autonomic nervous system leading to rises in blood pressure and heart rate, stress potentially mediated by annoyance, and disturbed sleep. However, the number of health studies available to date is limited.

Aircraft noise and cardiovascular disease hospitalizations and mortality

Two large studies have found associations between aircraft noise and heart disease and stroke; one of these examined hospitalization rates in 6 million adults aged 65 years and over living near 89 US airports,[41] the second examined hospitalization and mortality in a population of 3.6 million potentially affected by noise from London Heathrow airport.[42] These studies used a small area (ecological) not individual-level design, so may not have fully accounted for confounding factors. Two individual-level studies have found associations between heart disease and stroke in subgroups who had lived in the same place for >15–20 years; one a cross-sectional study of approximately 5000 individuals living near seven European airports,[43] the second a census-based study of 4.6 million individuals in the Swiss National cohort.[44] A further two individual-level studies, of heart disease mortality in adults in Vancouver,[45] and stroke mortality in 64,000 adults living in Denmark,[46] did not find associations possibly due to the fact that the study areas had low levels of noise.

Aircraft noise and hypertension

Two meta-analyses[47],[48] relating to seven epidemiological studies in total have found associations between chronic aircraft noise exposure and hypertension in adults (meta-analyses combine evidence from several studies and are considered to provide the highest ranked research and to provide stronger evidence than single studies). Results from the meta-analyses are consistent with findings from meta-analyses of studies investigating road noise that have also shown associations with hypertension.[49] Aircraft noise has been associated but not consistently so with raised blood pressure in children in a number of studies, of which the largest involved 62 schools around London Heathrow and Schiphol airport.[50] The findings from epidemiological studies are supported by experimental and field studies that have demonstrated short-term effects of aircraft noise on blood pressure in adults. A field study of 140 individuals living near four European airports found increases in blood pressure measurements during the night sleeping period related to aircraft movements.[51] Short-term experimental studies in healthy adults[52] and those with existing CVD[53] have found dose–response associations between aircraft noise at night and next-morning blood pressure and blood vessel functioning.

Aircraft noise and cardiovascular risk factors

Few studies have been conducted looking at cardiovascular risk factors, e.g., biomarkers, adiposity, and diabetes. Two experimental studies of aircraft noise recordings played at different volumes during sleep did not find associations with inflammatory markers (Interleukin6, C-Reactive Protein) in the blood the following morning, while findings were inconsistent with adrenaline and cortisol.[52],[53] A study of approximately 5000 individuals in Stockholm followed up for 10 years found a L_{den} 5 dB(A) increase in aircraft noise was associated with a greater increase in waist circumference of 1.5 cm (95% confidence interval: 1.13–1.89 cm)[54] but no associations were seen with body mass index.[55] The authors suggested that increased stress hormones might contribute to central obesity, measured by waist circumference and waist-hip ratio.

Aircraft noise and birth outcomes

There are only a small number of studies available. A recent systematic review[56] found that four of the five studies identified examining birth weight found associations between lower birth weight and higher aircraft noise.

The largest study was conducted around a US military airfield in Japan,[57] examining 160,460 birth records from 1974 to 1993. The studies reviewed did not score highly on quality assessment and the authors of the systematic review concluded that more and better designed studies were needed.

Aircraft noise effects on psychological health

The evidence for aircraft noise exposure being linked to poorer well-being, lower quality of life, and psychological ill health is not as strong or consistent as for other health outcomes, such as hypertension. A study of 2300 residents near Frankfurt airport found that annoyance but not aircraft noise levels per se ($L_{Aeq,16hours}$, L_{night}, L_{den}) was associated with self-reported lower quality of life.[58] The HYpertension and Exposure to Noise near Airports (HYENA) study, found that a 10 dB increase in day-time ($L_{Aeq,16hours}$) or night-time (L_{night}) aircraft noise was associated with a 28% increase in anxiety medication use, but not with sleep medication or anti-depressant medication use.[59] A sub-study of the HYENA study found that salivary cortisol (a stress hormone that is higher in people with depression) was 34% higher for women exposed to aircraft noise above 60 dB $L_{Aeq,24hours}$, compared to women exposed to less than 50 dB $L_{Aeq,24hours}$,[60] but no associations were found for men. Studies in schools around London Heathrow airport found no effect of aircraft noise at school on children's psychological health or cortisol levels.[61],[62],[63] However, the West London Schools Study of 451 children aged 8–11 years found higher rates of hyperactivity symptoms for children attending schools exposed to aircraft noise exposure >63 dB $L_{Aeq,16hours}$ compared to children in schools exposed to levels below 57 dB $L_{Aeq,16hours}$.[62] A similar effect was observed in the RANCH study.[63] These increases in hyperactivity symptoms, whilst statistically significant, were very small and most likely not of clinical relevance.

Conclusions

There is a good biological plausibility by which noise may affect health in terms of impacts on the autonomic system, annoyance and sleep disturbance. Studies are suggestive of impacts on cardiovascular health especially hypertension, but limited and inconclusive with respect to quantification of these, with a relatively small number of studies conducted to date. More studies are needed to better define exposure–response relationships, the relative importance of night versus daytime noise and the best noise metrics for health studies (e.g., number of aircraft noise events versus average noise level).

Civilian Supersonic Aircraft: A Future Source of Aviation Noise

Supersonic aircraft

All of the noise sources described thus far in this report pertain to noise in the vicinity of airports. In the future, however, it may be necessary to account for a new type of noise source that will be heard while the aircraft is in flight. Aircraft manufacturers are currently working on the design of supersonic civilian aircraft that produce a transient noise called a sonic boom. The sonic boom is pulled along with the aircraft analogous to the way a boat on a lake pulls its wake through the water. And just as the boat's wake impinges on the entire shoreline as it travels the lake, a supersonic aircraft's sonic boom impinges on the earth's surface for the entire supersonic journey. Because civilian supersonic aircraft are envisioned flying at altitudes upward of 15 km, the sonic boom noise might be heard within a corridor on the ground having a width of perhaps 100 km, centered on the aircraft's ground track. Fortunately, this noise will likely have a much lower level than traditional supersonic aircraft such as Concorde due to the progress of technologists working to reduce the boom.

Noise regulations for sonic booms

Currently the world's noise regulations for supersonic aircraft exist from a time when the Concorde supersonic airliner was flying. The now-retired Concorde had a loud sonic boom, and the ICAO's Assembly Resolution A38-17 Appendix G protects individuals by reaffirming their position that "no unacceptable situation for the public is created by sonic boom from supersonic aircraft in commercial service." But there has been substantial progress during the last few years by industry, academia, and government laboratories developing supersonic aircraft technology, and by regulatory authorities that would certify such low-boom vehicles.[64],[65],[66] It is unclear how soon the new supersonic aircraft will be in widespread use, perhaps 20–30 years from now.

Conclusions

Noise is considered one, if not the most detrimental environmental effect of aviation. There is abundant evidence that aircraft noise exposure in the vicinity of airports is related to annoyance, and some evidence that the annoyance response has increased in recent years. There is sufficient evidence for a marked negative effect of

aircraft noise exposure on children's cognitive skills, with some evidence that insulation of schools could mitigate this. There is also sufficient evidence that aircraft noise disturbs sleep and can impair sleep recuperation, but further research is needed to establish reliable noise exposure–response relationships and best mitigation strategies. Studies are suggestive of impacts of aircraft noise on health, but inconclusive with respect to quantification of exposure–response relationships, with a limited number of studies conducted to date. Mitigation of these various noise effects is necessary to protect the population living in the vicinity of airports and to address potential constraints to air traffic movements.

Financial support and sponsorship

SAHSU funding statement: MB and VS were funded by the U.S. Federal Aviation Administration (FAA) Office of Environment and Energy as a part of ASCENT Project 17 under FAA Award Numbers 13-C-AJFE-UPENN-001 and 13-C-AJFE-UPENN-002 (MB) and under ASCENT Projects 5, 7, 40, 41, and 42 under FAA Award Numbers 13-C-AJFE-PSU-001, 003, 005, 013, 015, 020, 021, 023, and 029 (VS). Any opinions, findings, and conclusions or recommendations expressed in this material are those of the authors and do not necessarily reflect the views of the FAA or other ASCENT sponsors. The work of the UK Small Area Health Statistics Unit (AH) is funded by Public Health England as a part of the MRC-PHE Centre for Environment and Health, funded also by the UK Medical Research Council.[70]

Conflicts of interest

There are no conflicts of interest.

References

1. Fields JM, De Jong RG, Gjestland T, Flindell IH, Job RF, Kurra S *et al*. Standardized general-purpose noise reaction questions for community noise surveys: Research and a recommendation. J Sound Vibr 2001;242:641-79.

2. IS Organization. ISO TS 15666: Acoustics – Assessment of Noise Annoyance by Means of Social and Socio-Acoustic Surveys; 2003.

3. Fields JM. Effect of personal and situational variables on noise annoyance in residential areas. J Acoust Soc Am 1993;93:2753-63.

4. Miedema HM, Vos H. Demographic and attitudinal factors that modify annoyance from transportation noise. J Acoust Soc Am 1999;105:3336-44.

5. Job RF. Community response to noise – A review of factors influencing the relationship between noise exposure and reaction. J Acoust Soc Am 1988;83:991-1001.

6. Guski R. Personal and social variables as co-determinants of noise annoyance. Noise Health 1999;1:45-56. [PUBMED] [Full text]

7. Miedema HM, Oudshoorn CG. Annoyance from transportation noise: Relationships with exposure metrics DNL and DENL and their confidence intervals. Environ Health Perspect 2001;109:409-16.

8. Janssen SA, Vos H, van Kempen EE, Breugelmans OR, Miedema HM. Trends in aircraft noise annoyance: The role of study and sample characteristics. J Acoust Soc Am 2011;129:1953-62.

9. Babisch W, Houthuijs D, Pershagen G, Cadum E, Katsouyanni K, Velonakis M *et al*. Annoyance due to aircraft noise has increased over the years – Results of the HYENA study. Environ Int 2009;35:1169-76.

10. Fidell S, Silvati L. Social survey of community response to a step change in aircraft noise exposure. J Acoust Soc Am 2002;111:200-9.

11. Brink M, Wirth KE, Schierz C, Thomann G, Bauer G. Annoyance responses to stable and changing aircraft noise exposure. J Acoust Soc Am 2008;124:2930-41.

12. Fidell S, Mestre V, Schomer P, Berry B, Gjestland T, Vallet M *et al*. A first-principles model for estimating the prevalence of annoyance with aircraft noise exposure. J Acoust Soc Am 2011;130:791-806.

13. Miedema HM, Vos H, de Jong RG. Community reaction to aircraft noise: Time-of-day penalty and tradeoff

between levels of overflights. J Acoust Soc Am 2000;107:3245-53.

14. Bates J, Taylor J, Flindell I, Humpheson D, Pownall C, Woolley A. Attitudes to noise from aviation sources in England (ANASE). Report MVA Project Number C34351. Great Britain: MVA Consultancy; 2007.

15. Fields JM. The effect of numbers of noise events on people's reactions to noise: An analysis of existing survey data. J Acoust Soc Am 1984;75:447-67.

16. Schreckenberg D, editor. Aircraft Noise Annoyance and Residents' Acceptance and Use of Sound Proof Windows and Ventilation Systems. New York City, NY, USA: Internoise; 2012.

17. Clark C. Aircraft Noise Effects on Health: Report Prepared for the UK Airport Commission. Report Number 150427. London: Queen Mary University of London; 2015.

18. Stansfeld SA, Berglund B, Clark C, Lopez-Barrio I, Fischer P, Ohrstrom E *et al*. Aircraft and road traffic noise and children's cognition and health: A cross-national study. Lancet 2005;365:1942-9.

19. Clark C, Martin R, van Kempen E, Alfred T, Head J, Davies HW *et al*. Exposure-effect relations between aircraft and road traffic noise exposure at school and reading comprehension – The RANCH project. Am J Epidemiol 2006;163:27-37.

20. Clark C, Crombie R, Head J, van Kamp I, van Kempen E, Stansfeld SA. Does traffic-related air pollution explain associations of aircraft and road traffic noise exposure on children's health and cognition? A secondary analysis of the United Kingdom sample from the RANCH project. Am J Epidemiol 2012;176:327-37.

21. Stansfeld SA, Hygge S, Clark C, Alfred T. Night time aircraft noise exposure and children's cognitive performance. Noise Health 2010;12:255-62.
[PUBMED] [Full text]

22. Hygge S, Evans GW, Bullinger M. A prospective study of some effects of aircraft noise on cognitive performance in schoolchildren. Psychol Sci 2002;13:469-74.

23. Sharp B, Connor TL, McLaughlin D, Clark C, Stansfeld SA, Hervey J. Assessing Aircraft Noise Conditions Affecting Student Learning. Washington, DC, USA: Transportation Research Board of the National Academies; 2014.

24. Stansfeld S, Clark C. Health effects of noise exposure in children. Curr Environ Health Rep 2015;2:171-8.

25. Evans G, Lepore S. Non-auditory effects of noise on children: A critical review. Child Environ 1993;10:42-72.

26. WHO. Guidelines for Community Noise. Geneva: World Health Organization Europe; 2000.

27. Fritschi L, Brown AL, Kim R, Schwela DH, Kephalopoulos S, editors. Burden of Disease From Environmental Noise. Bonn, Germany: World Health Organization (WHO); 2011.

28. Muzet A. Environmental noise, sleep and health. Sleep Med Rev 2007;11:135-42.

29. Dang-Vu TT, McKinney SM, Buxton OM, Solet JM, Ellenbogen JM. Spontaneous brain rhythms predict sleep stability in the face of noise. Curr Biol 2010;20:R626-7.

30. Basner M, Müller U, Griefahn B. Practical guidance for risk assessment of traffic noise effects on sleep. Appl Acoust 2010;71:518-22.

31. Basner M, Müller U, Elmenhorst E-M. Single and combined effects of air, road, and rail traffic noise on sleep and recuperation. Sleep 2011;34:11-23.

32. Brink M, Basner M, Schierz C, Spreng M, Scheuch K, Bauer G *et al*. Determining physiological reaction probabilities to noise events during sleep. Somnologie 2009;13:236-43.

33. Cassel W, Ploch T, Griefahn B, Speicher T, Loh A, Penzel T *et al*. Disturbed sleep in obstructive sleep apnea expressed in a single index of sleep disturbance (SDI). Somnologie 2008;12:158-64.

34. Basner M. Nocturnal aircraft noise increases objectively assessed daytime sleepiness. Somnologie 2008;12:110-7.

35. Elmenhorst EM, Elmenhorst D, Wenzel J, Quehl J, Mueller U, Maass H *et al*. Effects of nocturnal aircraft

noise on cognitive performance in the following morning: Dose–response relationships in laboratory and field. Int Arch Occup Environ Health 2010;83:743-51.

36. Jarup L, Babisch W, Houthuijs D, Pershagen G, Katsouyanni K, Cadum E *et al*. Hypertension and exposure to noise near airports: The HYENA study. Environ Health Perspect 2008;116:329-33.

37. Basner M, Isermann U, Samel A. Aircraft noise effects on sleep: Application of the results of a large polysomnographic field study. J Acoust Soc Am 2006;119:2772-84.

38. Pearsons K, Barber D, Tabachnick BG, Fidell S. Predicting noise-induced sleep disturbance. J Acoust Soc Am 1995;97:331-8.

39. Marks A, Griefahn B, Basner M. Event-related awakenings caused by nocturnal transportation noise. Noise Control Eng J 2008;56:52-62.

40. Babisch W. The noise/stress concept, risk assessment and research needs. Noise Health 2002;4:1-11. [PUBMED] [Full text]

41. Correia AW, Peters JL, Levy JI, Melly S, Dominici F. Residential exposure to aircraft noise and hospital admissions for cardiovascular diseases: Multi-airport retrospective study. BMJ 2013;347:f5561.

42. Hansell AL, Blangiardo M, Fortunato L, Floud S, de Hoogh K, Fecht D *et al*. Aircraft noise and cardiovascular disease near Heathrow airport in London: Small area study. BMJ 2013;347:f5432.

43. Floud S, Blangiardo M, Clark C, Babisch W, Houthuijs D, Pershagen G *et al*. Reported heart disease and stroke in relation to aircraft and road traffic noise in six European countries – The HYENA study. Epidemiology 2012;23:E-039.

44. Huss A, Spoerri A, Egger M, Roosli M. Aircraft noise, air pollution, and mortality from myocardial infarction. Epidemiology 2010;21:829-36.

45. Gan WQ, Davies HW, Koehoorn M, Brauer M. Association of long-term exposure to community noise and traffic-related air pollution with coronary heart disease mortality. Am J Epidemiol 2012;175:898-906.

46. Sorensen M, Hvidberg M, Andersen ZJ, Nordsborg RB, Lillelund KG, Jakobsen J *et al*. Road traffic noise and stroke: A prospective cohort study. Eur Heart J 2011;32:737-44.

47. Babisch W, Kamp I. Exposure–response relationship of the association between aircraft noise and the risk of hypertension. Noise Health 2009;11:161-8. [PUBMED] [Full text]

48. Huang D, Song X, Cui Q, Tian J, Wang Q, Yang K. Is there an association between aircraft noise exposure and the incidence of hypertension? A meta-analysis of 16784 participants. Noise Health 2015;17:93-7. [PUBMED] [Full text]

49. van Kempen E, Babisch W. The quantitative relationship between road traffic noise and hypertension: A meta-analysis. J Hypertens 2012;30:1075-86.

50. van Kempen E, van Kamp I, Fischer P, Davies H, Houthuijs D, Stellato R *et al*. Noise exposure and children's blood pressure and heart rate: The RANCH project. Occup Environ Med 2006;63:632-9.

51. Haralabidis AS, Dimakopoulou K, Vigna-Taglianti F, Giampaolo M, Borgini A, Dudley ML *et al*. Acute effects of night-time noise exposure on blood pressure in populations living near airports. Eur Heart J 2008;29:658-64.

52. Schmidt FP, Basner M, Kroger G, Weck S, Schnorbus B, Muttray A *et al*. Effect of nighttime aircraft noise exposure on endothelial function and stress hormone release in healthy adults. Eur Heart J 2013;34:3508-14a.

53. Schmidt F, Kolle K, Kreuder K, Schnorbus B, Wild P, Hechtner M *et al*. Nighttime aircraft noise impairs endothelial function and increases blood pressure in patients with or at high risk for coronary artery disease. Clin Res Cardiol 2015;104:23-30.

54. Eriksson C, Hilding A, Pyko A, Bluhm G, Pershagen G, Ostenson CG. Long-term aircraft noise exposure and body mass index, waist circumference, and type 2 diabetes: A prospective study. Environ Health Perspect 2014;122:687-94.

55. Pyko A, Eriksson C, Oftedal B, Hilding A, Ostenson CG, Krog NH *et al*. Exposure to traffic noise and markers of obesity. Occup Environ Med 2015;72:594-601.

56. Ristovska G, Laszlo HE, Hansell AL. Reproductive outcomes associated with noise exposure – A

systematic review of the literature. Int J Environ Res Public Health 2014;11:7931-52.

57. Matsui T, Matsuno T, Ashimine K, Miyakita T, Hiramatsu K, Yamamoto T. [Association between the rates of low birth-weight and/or preterm infants and aircraft noise exposure]. Nihon Eiseigaku Zasshi 2003;58:385-94.

58. Schreckenberg D, Meis M, Kahl C, Peschel C, Eikmann T. Aircraft noise and quality of life around Frankfurt Airport. Int J Environ Res Public Health 2010;7:3382-405.

59. Floud S, Vigna-Taglianti F, Hansell A, Blangiardo M, Houthuijs D, Breugelmans O *et al*. Medication use in relation to noise from aircraft and road traffic in six European countries: Results of the HYENA study. Occup Environ Med 2011;68:518-24.

60. Selander J, Bluhm G, Theorell T, Pershagen G, Babisch W, Seiffert I *et al*. Saliva cortisol and exposure to aircraft noise in six European countries. Environ Health Perspect 2009;117:1713-7.

61. Haines MM, Stansfeld SA, Job RF, Berglund B, Head J. Chronic aircraft noise exposure, stress responses, mental health and cognitive performance in school children. Psychol Med 2001;31:265-77.

62. Haines MM, Stansfeld SA, Brentnall S, Head J, Berry B, Jiggins M *et al*. The West London Schools Study: The effects of chronic aircraft noise exposure on child health. Psychol Med 2001;31:1385-96.

63. Stansfeld SA, Clark C, Cameron RM, Alfred T, Head J, Haines MM *et al*. Aircraft and road traffic noise exposure and children's mental health. J Environ Psychol 2009;29:203-7.

64. Fisher L, Liu L, Maurice L, Shepherd K. Supersonic aircraft: Balancing fast, affordable, and green. Int J Aeroacoust 2004; 3:181-97.

65. Liu S, Sparrow V, Makino Y. Establishing Noise Standards for Civil Supersonic Aircraft: Status Report Published in: ICAO Environmental Report 2013 Aviation and Climate Change; 2013. pp. 73-7.

66. Maglieri D, Bobbitt P, Plotkin K, Shepherd K, Coen P, Richwine D. Sonic Boom: Six Decades of Research. NASA SP-2014-622. Hampton, Virginia, United States: NASA Langley Research Center; 2014.

67. He Q, Wollersheim C, Locke M, Waitz I. Estimation of the global impacts of aviation-related noise using an income-based approach. Transport Policy 2014;34:85-101.

68. Smith MJ. Aircraft Noise. Cambridge: Cambridge University Press 1989.

69. Ruijgrok GJ. Elements of Aviation Acoustics. Amsterdam, The Netherlands: IOS Press; 2004.

70. Zaporozhets O, Tokarev V, Attenborough K. Aircraft Noise: Assessment, Prediction, and Control. Abingdon, UK: SPON Press; 2011.

Correspondence Address:
Mathias Basner
Associate Professor of Sleep and Chronobiology in Psychiatry, Unit for Experimental Psychiatry, Division of Sleep and Chronobiology, University of Pennsylvania Perelman School of Medicine, 1019 Blockley Hall, 423 Guardian Drive, Philadelphia, PA 19104-6021
USA
Login to access the email ID

Source of Support: None, **Conflict of Interest:** None

DOI: 10.4103/nah.NAH_104_16

ISSN: Print -1463-1741, Online - 1998-4030
Editorial and Ethics Policies
(cc) BY-NC-SA View mobile site
ISSN: Print -1463-1741, Online - 1998-4030
Editorial and Ethics Policies
(cc) BY-NC-SA View mobile site
ISSN: Print -1463-1741, Online - 1998-4030

This Page Intentionally Left Blank.

Comment #	Author	Topic	Comment	Response
2-1	Town of Milton Board of Selectmen	Content / Environmental Impacts	The 2016 EDR and prior EDRs begin with a discussion of the economic contributions Logan International Airport makes to the Boston, the Massachusetts, and the New England economies. While Milton acknowledges and appreciates these contributions, we believe the 2016 Environmental Data Report should begin and end with the important environmental impacts of the presence of the airport on all its surrounding communities and residents, i.e., the "Boston catchment" communities, to utilize the language of the 2016 EDR. We do not believe enough emphasis is placed on the impacts to the communities outside the immediate boundaries of the airport.	This *2017 Environmental Status and Planning Report (ESPR)* considers the economic conditions and contributions to the local, regional, and national areas to provide context in several of the technical chapters. Massport recognizes the impact Logan Airport has on local communities. Chapter 1, *Introduction/Executive Summary,* includes a summary of environmental impacts for 2017 and the Future Planning Horizon (the next 10 to 15 years). Each of the technical chapters provide detailed information on environmental conditions in and around Logan Airport. For example, Chapter 6, *Noise Abatement* assesses noise conditions well beyond the borders of the airport, and Chapter 7, *Air Quality Improvement* considers regional air quality conditions.
2-2	Town of Milton Board of Selectmen	Content / Environmental Impacts	We believe Massport has downplayed the speed and intensity of these changes over the last several years, and we emphasize the necessity of considering the impact these changes have on both airport operations and on the residents impacted by airport operations throughout the Boston catchment area.	This *2017 ESPR* provides an overview of passenger, operations, and environmental impacts over the years, and forecasts to 50 million annual air passengers to have an idea of how Logan Airport will evolve. Throughout the ESPR, 1998, 2000, 2010, and 2016 are used as comparison years to 2017 to reflect on how Logan Airport has changed. This analysis helps Massport in identifying Logan Airport's present and future needs.
2-3	Town of Milton Board of Selectmen	Content / Environmental Impacts	The fact that disruption caused by Logan Airport is growing should be acknowledged within the 2016 EDR and Massport should have a plan to provide relief from this disruption to the affected communities.	Growth at Logan Airport can be attributed to the strong local, regional, and national economies. Massport has a strategy to address these challenges in a manner that will allow Logan Airport to grow in a sustainable and environmentally-responsible way. Chapter 1, *Introduction/Executive Summary,* summarizes Massport's plan to address growth in each environmental category.
2-4	Town of Milton Board of Selectmen	Noise	We request that the Secretary direct Massport and the MCAC to immediately prepare a plan to address and mitigate the noise impacts from RNAVs within Milton, and to share it with Milton.	Massport engages directly with the community on noise and other issues through the Massport Community Advisory Committee (CAC), which Milton is an active member. The appropriate forum for further noise issues and discussions continues to be through the Massport CAC. Massport is aware of the effects of RNAV procedures on the community and has partnered with the Federal Aviation Administration (FAA) to study these effects and analyze opportunities for mitigation of impacts. The RNAV study team has met several times with the Massport CAC to present its findings and provide updates on progress. Additional details can be found in Chapter 6, *Noise Abatement.* This work is ongoing and progress will continue to be reported in future Environmental Data Reports (EDRs) and ESPRs.
2-5	Town of Milton Board of Selectmen	Noise	Unless and until this situation is rectified, and Massport either provides a community by community analysis, or the RNAVs and overflights are distributed more fairly, the EDRs will continue to provide an inaccurate accounting of the real impacts of Logan operations on Milton and other communities.	The EDRs/ESPRs provide a current detailed snapshot of the noise levels within the day-night average sound level (DNL) 60 dB contour (5 dB below federal guidelines) at Logan Airport. Massport develops all of its noise results by modeling all of the radar data as flown during that year. This includes the RNAV procedures at Logan Airport. Table H-26 in Appendix H provides noise levels by US Census Block group down to the DNL 50 dB level, well below the FAA guidelines.
2-6	Town of Milton Board of Selectmen	Noise	We request that the Secretary work with Massport, the MCAC, and Milton to implement additional late night aircraft restrictions, similar to those set forth in 740 CMR 24.04, which are more protective of Milton and its residents. In particular, it is important to discuss restrictions on RNAV usage and routes that overfly residential neighborhoods, including spreading the routes further so that the nighttime noise is less concentrated in residential neighborhoods, or moving routes over the ocean during certain periods of time.	Offshore approaches are prioritized for nighttime arrivals when possible, including a recently developed RNAV for quieter approach to Runway 33L. Runway 33L is the preferred runway for arrivals at night. Safety considerations preclude a permanent nighttime closure of any runway. Massport will continue to work with Milton, and other communities, through the Massport CAC. The appropriate forum for further noise issues and discussions continues to be through the Massport CAC. Any new access restrictions to Logan Airport unless grandfathered in, are prohibited by current federal laws.
2-7	Town of Milton Board of Selectmen	Noise	Specifically, as there are already nighttime restrictions on arrivals to runway 22 and departures for runway 4L, we request similar restrictions (no arrivals between 11:00 PM and 6:00 AM) for on runway 4R. See Massachusetts Port Authority ("Massport") Noise Rules and Regulations I.1(b), Summary of Runway Use Restrictions, Boston Logan International Airport (May 2, 2016) (also referenced in FAA BOS ATCT Noise Abatement Order 7040.1H).	Those restrictions were enacted prior to the Airport Noise and Capacity Act (ANCA) and are grandfathered at Logan Airport. Any new access restrictions to Logan Airport are prohibited by current federal laws. Massport will continue to work with Milton, and other communities, through the Massport CAC. The appropriate forum for further noise issues and discussions continues to be through the Massport CAC.

Comment #	Author	Topic	Comment	Response
2-8	Town of Milton Board of Selectmen	Noise	We again request that the Secretary direct Massport and the MCAC to promptly develop a system for the fair and equitable distribution of aircraft overflights that provides real relief to the highly impacted surrounding communities.	Massport engages directly with the community on noise and other issues through the Massport CAC, which Milton is an active member. The Massport CAC is a state legislated body and is the official forum for the community and Massport to discuss noise related issues including individual community ideas related to equitable distribution of noise. Massport will continue to engage with the Town of Milton through the Massport CAC.
2-9	Town of Milton Board of Selectmen	Air Quality / Noise	We request that the Secretary direct Massport, in conjunction with the Department of Public Health ("DPH") and the Department of Environmental Protection ("DEP"), to conduct noise and air pollution studies in Milton and other communities. which receive a substantial number of low flying arrival aircraft.	The FAA has ongoing studies and research related to noise exposure and sound insulation. The FAA is currently researching the noise exposure threshold. Massport will continue to follow FAA requirements and thresholds. Massport provided an update on the status and findings of the Massachusetts Department of Public Health (MassDPH) Logan Airport Health Study and Massport's air quality studies in the recent EDRs and ESPRs. The latest update on the health study is provided in Chapter 7, *Air Quality/Emissions Reduction.* The results of the health studies are also available online at: http://www.mass.gov/eohhs/docs/dph/environmental/investigations/logan/logan-airport-health-study-final.pdf. Massport will support and closely follow the findings of research studies required under the FAA Reauthorization Act of 2018. Specific studies of interest include evaluation of an alternative airplane noise metric, assessment of lead in aviation gasoline and mitigation to reduce ambient lead concentrations; analysis of the relationship between jet aircraft approach and takeoff speeds and corresponding noise impacts on surrounding communities; review of relationship between aircraft noise exposure and its effects on communities around airports; and the study of potential health and economic impacts of overflight noise (which includes Boston as a case study). See https://www.congress.gov/bill/115th-congress/house-bill/4/text for additional information.
2-10	Town of Milton Board of Selectmen	Air Quality / Noise	We further request that the scope of the future EDRs (and ESPRs), beginning with the next EDR and ESPR, be expanded to consider the health impacts from increased and concentrated arrival and departure operations due to RNAVs, and that pollution data be measured for every community under any of the many Logan RNAVs.	The noise and air quality modeling conducted for the *2017 ESPR* considers the volume of aircraft operations and therefore the air quality modeling results account for any increases or decreases in the number of aircraft arrivals and departure operations. Since ESPR documents are focused on forecasting and the future outlook of passenger and operations at Logan Airport, the noise and air quality modeling discussed in the *2017 ESPR* includes a discussion and analysis of the forecasted activity levels, and the planning horizon when Logan Airport is expected to reach 50 million air passengers. Noise modeling accounts for aircraft location and therefore reflects the concentration of noise impacts in the surrounding communities. The FAA Reauthorization Act of 2018 includes required consideration of community noise concerns particularly when relating to a new RNAV departure procedure over noise sensitive areas, and also calls for community involvement in FAA NextGen projects located in metroplexes. See https://www.congress.gov/bill/115th-congress/house-bill/4/text for additional information.
2-11	Town of Milton Board of Selectmen	Activity Levels / Environmental Impacts	First, we believe it is important to consider the off-airport impacts of the growth of Logan itself and the increased passenger throughput and increased aircraft operations at Logan. The increased demand for airport services impacts the surrounding communities by increasing the volume and concentration of overflights, and by increasing the amount of nighttime operations and nighttime overflights. Each of these impacts must be studied - from noise to pollution and more, to have a true assessment of the environmental impacts resulting from operations at Logan.	The *2017 ESPR's* noise and air quality modeling considers the volume of aircraft operations and therefore the air quality modeling results account for any increases or decreases in the number of arrivals and departure operations. Massport is aware of the effects of RNAV procedures on the community, and has partnered with the FAA to study these effects and analyze opportunities for mitigation of impacts. This partnership is the first in the nation between an airport operator and the FAA on this topic. This work is ongoing and progress will continue to be reported in future EDR/ESPRs.
2-12	Town of Milton Board of Selectmen	Noise	Second, the scope must include analysis of the cumulative impacts from increasing numbers of RNAVs flown over surrounding communities.	The existing noise modeling in the EDRs/ESPRs accounts for all flight path routes over each community. The DNL metric remains the FAA standard metric for reporting noise levels within the community both near the Airport and for air traffic procedure evaluations. Separate from the EDR/ESPR efforts, the RNAV study looked at other metrics that may be useful for reporting noise information for communities under RNAV routes.

Comment #	Author	Topic	Comment	Response
2-13	Town of Milton Board of Selectmen	Noise	Third, we urge Massport and the Secretary to move to a more updated method for noise assessment, and either discontinue using the DNL standard, or reduce the threshold at which noise impacts are considered significant. The DNL standard "masks" the acute impacts a succession of aircraft flying over a home has on the sleeping residents within, and also masks the acute impacts felt in a community when it is overflown for hours on end, with little break in the incoming or departing aircraft.	Massport follows FAA guidance and regulations for reporting aircraft noise and establishing "significance levels" for noise. The FAA is conducting a nationwide study on aircraft annoyance and the DNL metric. Massport is following this study closely. Information on the study can be found at https://www.faa.gov/news/press_releases/news_story.cfm?newsId=18774. The FAA Reauthorization Act of 2018 requires that this study is completed within a year of the Act's passing. Massport will review the findings of the study when made public.
2-14	Town of Milton Board of Selectmen	Community Engagement	Finally, we urge Massport and the Secretary to collaborate with the impacted communities, and to work with them directly, rather than just giving lip service to working with them.	Massport engages directly with the community on noise and other issues through the Massport CAC, which Milton is an active member. Massport also publishes and welcomes public comments on the EDR and ESPR, which report on environmental impacts. Massport seeks continual engagement with the public on specific projects to provide information and gather feedback. Communities around Massport can submit public comment or noise complaints through the Massport and Massport CAC websites: http://www.massport.com/massport/about-massport/contact/ and http://massportcac.org/noise/
2-15	Town of Milton Board of Selectmen	Community Engagement	It is appropriate to acknowledge that multiple communities surrounding Logan (not just Milton) take the brunt of the impact of the operations of Logan. These communities should have direct and regular access to Massport and the Secretary, and both agencies should be willing to work on real and meaningful solutions to address the problems from airport operations - especially noise and pollution -- occurring in those communities. While we understand some of that work must be done via the MCAC, the large size and the organization of the MCAC has the unintentional effect of diluting the voices of the most affected communities.	Massport engages directly with the surrounding community on noise and other issues through the Massport CAC, which Milton is an active member. Massport coordinates with the FAA and Massport CAC on matters related to noise abatement efforts, specifically runway use. Massport also publishes and welcomes public comments on the EDR and ESPR, which report on noise issues, and seeks continual engagement with the public on specific projects to provide information and gather feedback.
2-16	Town of Milton Board of Selectmen	Noise	Direct Massport to prepare a plan to address and mitigate the noise impacts from the RNAVs overflying Milton, and to share it with Milton, within the next three (3) months.	The appropriate forum for further noise issues and discussions continues to be through the Massport CAC, of which Milton is a member. Massport is aware of the effects of RNAV procedures on the community, and has partnered with the FAA to study these effects and analyze opportunities for mitigation of impacts. The RNAV study team has met several times with the Massport CAC to present its findings and provide updates on progress. Additional details can be found in the Chapter 6, *Noise Abatement*. This work is ongoing and progress will continue to be reported in future EDR/ESPRs.
2-17	Town of Milton Board of Selectmen	Noise	Work with Massport, the MCAC, and Milton to develop and implement additional late night/early morning aircraft overflight restrictions which are more protective of Milton and its residents, including consideration of an 11:00 PM to 6:00 AM landing prohibition on runway 4R.	Offshore approaches are prioritized for nighttime arrivals when possible, including a recently developed RNAV for quieter approach to Runway 33L. Runway 33L is the preferred runway for arrivals at night. Safety considerations preclude a permanent nighttime closure of any runway. Massport will continue to work with Milton, and other communities, through the Massport CAC. The appropriate forum for further noise issues and discussions continues to be through the Massport CAC. Any new access restrictions to Logan Airport unless grandfathered in, is prohibited by current federal laws.
2-18	Town of Milton Board of Selectmen	Noise	Direct Massport and the MCAC to promptly develop a system for the fair and equitable distribution of aircraft overflights that provides real relief to the highly impacted surrounding communities, especially those that are under multiple RNAVs.	Massport engages directly with the community on noise and other issues through the Massport CAC, which Milton is an active member. The Massport CAC is a state legislated body and is the official forum for the community and Massport to discuss noise related issues including individual community ideas related to equitable distribution of noise. Massport will continue to engage with the Town of Milton through the Massport CAC.

Comment #	Author	Topic	Comment	Response
2-19	Town of Milton Board of Selectmen	Noise / Air Quality	Direct Massport to collaborate with DPH and DEP to develop and conduct noise and air pollution studies in highly impacted surrounding communities, especially those that are under multiple RNAVs.	Massport provides an update on the status and findings of the MassDPH Logan Airport Health Study and Massport's air quality studies in the recent EDRs and ESPRs. The latest update on the health studies is provided in Chapter 7, *Air Quality/Emissions Reduction.* The results of the health studies are also available online at http://www.mass.gov/eohhs/docs/dph/environmental/investigations/logan/logan-airport-health-study-final.pdf. Massport will support and closely follow the findings of research studies required under the FAA Reauthorization Act of 2018. Specific studies of interest include evaluation of an alternative airplane noise metric, assessment of lead in aviation gasoline and mitigation to reduce ambient lead concentrations; analysis of the relationship between jet aircraft approach and takeoff speeds and corresponding noise impacts on surrounding communities; review of the relationship between aircraft noise exposure and its effects on communities around airports; and the study of potential health and economic impacts of overflight noise (which includes Boston as a case study). The FAA Reauthorization Act of 2018 includes required consideration of community noise concerns particularly when relating to a new RNAV departure procedure over noise sensitive areas, and also calls for community involvement in FAA NextGen projects located in metroplexes. See https://www.congress.gov/bill/115th-congress/house-bill/4/text for additional information.
2-20	Town of Milton Board of Selectmen	Noise / Air Quality	Direct Massport to consider off-airport noise and pollution impacts, including but not limited to the health impacts from increased and concentrated arrival and departure operations due to RNAVs, in all communities under any RNAV, in all future EDRs.	The *2017 ESPR's* noise and air quality modeling considers the volume of aircraft operations and therefore the air quality modeling results account for any increases or decreases in the number of arrivals and departure operations in 2017, as well as the Future Planning Horizon, and forecasted activity levels. Flight tracks and track use were developed from the current radar data sets and were used as Aviation Environmental Design Tool (AEDT) inputs for the forecast case. The resulting noise contours represent Massport's best estimates of future noise levels for a year when annual passenger counts reach 50 million. Massport is aware of the effects of RNAV procedures on the community, and has partnered with the FAA to study these effects and analyze opportunities for mitigation of impacts. This partnership is the first in the nation between an airport operator and FAA on this topic. This work is ongoing and progress will continue to be reported in future EDR/ESPRs. As noted above, the FAA Reauthorization Act of 2018 includes required consideration of community noise concerns particularly when relating to a new RNAV departure procedure over noise sensitive areas. See https://www.congress.gov/bill/115th-congress/house-bill/4/text for additional information.
2-21	Town of Milton Board of Selectmen	Noise / Air Quality	Direct Massport to include all of the points made above in the scope of the 2016 ESPR. This includes impacts to health from noise and pollution from: off-airport impacts of growth, cumulative impacts of RNAV overflights, increased nighttime operations, moving to updated noise measurements which are more protective of human health and which account for acute impacts more realistically than the DNL standard; and working directly with impacted communities to more fully understand and evaluate the human health effects from Logan operations.	Massport will continue to prepare the EDRs and ESPRs in accordance with the Secretary's Certificate. Massport will continue to model environmental impacts, including noise, in accordance with FAA standard methodologies. For example, Massport transitioned in 2017 to exclusively using the FAA AEDT noise model. Massport will continue to work with Milton, and other communities, through the Massport CAC. The appropriate forum for further noise and other environmental issues and discussions continues to be through the Massport CAC.

Astrid Weins, MD, PhD
50 Faunbar Avenue
Winthrop, MA 02152

July 31, 2018

The Honorable Matthew Beaton,
Secretary Executive Office of Energy and Environmental Affairs
Attention: MEPA Office EEA #3247
Anne Canady
100 Cambridge Street, Suite 900
Boston, MA 02114
Anne.Canady@state.ma.us

Re: Boston-Logan International Airport EDR 2016

Dear Secretary Beaton:

I am happy to have the opportunity to submit a few comments on the Boston-Logan International Airport 2016 Environmental Data Report (EDR). I am submitting them as a citizen of Winthrop's Cottage Hill neighborhood, as the mother of 2 young children (6 years and 18 months), and as a member of the Winthrop Board of Health.

In Winthrop, we are increasingly worried about the impacts of Massport on our town and its projected traffic increase over the next few years. My specific concerns I would like to address here are regarding small particle pollution, specifically affecting communities in <u>close</u> proximity of the airport, such as Winthrop and East Boston.

I have recently learned that small particle pollution is especially concentrated during take off (but also to a more limited degree during landing) of aircraft withing 300 ft below the aircraft. This means, this would not affect to a large degree communities further away, such as Medford and Milton etc., which are very outspoken in their opposition

to and concern about airport impacts to their citizens. This small particle pollution would be particularly concentrated above communities close to the airport, such as the Cottage Hill and Point Shirley Neighborhoods of Winthrop, right below the flight path of runway 9/27.

In addition to the pooled emission data you are presenting, for which trends are going up already in 2016 and are likely to go up for 2017 as well, I would like to see as a part of the next EDR, measurements of specific and independent small particle pollution below the take off and landing areas of close proximity communities, as it is this pollution that provides the strongest links to chronic respiratory diseases such as asthma and COPD. In addition, I would also welcome a new and comprehensive, independent health report specifically in these close proximity communities, which includes data gathered from local hospitals and physicians regarding chronic respiratory diseases in children and adults.

I do not believe that your comprehensive report addresses these issues adequately and I wish that in coming years, the most affected communities, such as East Boston and Winthrop, will receive more detailed information about air and noise pollution in general in a more timely fashion.

Sincerely,

Astrid Weins, MD, PD
Vice Chair
Winthrop Board of Health

Comment #	Author	Topic	Comment	Response
3-1	Astrid Weins, MD, PhD, Vice Chair, Winthrop Board of Health	Air Quality	I would like to see as part of the next EDR, measurements of specific and independent small particle pollution below the take off and landing areas of close proximity communities, as it is this pollution that provides the strongest links to chronic respiratory diseases such as asthma and COPD.	As part of the Massachusetts Environmental Policy Act (MEPA) Environmental Impact Report (EIR) Certificate for the Logan Airside Improvements Project, a two-year air quality monitoring study was undertaken in the communities near the airport - including those located near the take-off and landing areas. The data included particulate matter ($PM_{2.5}$) and Black Carbon particles and an assortment of volatile organic compounds (e.g., formaldehyde, naphthalene, etc.). Although partly inclusive of the particles, the smallest (e.g., ultrafine particles [UFP]) were not specifically measured. Another study conducted by the Massachusetts Department of Public Health (MassDPH), evaluated human health effects in communities located near the Airport. Among the findings was an elevated increase in the incidence of respiratory effects when compared to low exposure areas. However, the study also concluded that this outcome cannot be attributable to the Airport alone when combined with emissions from motor vehicle traffic, industrial facilities, etc. Logan Airport is a case study of a research effort undertaken by the FAA Center of Excellence for Alternative Jet Fuels and Environment, Aviation Sustainability Center (ASCENT). The research project measured and modeled UFP for one runway end at Logan Airport in July 2017 and separated contribution of aircraft sources from other sources. The study will include additional work to include both arrival and departure flight paths. Massport will report on the findings of the study in the next EDR, if available.
3-2	Astrid Weins, MD, PhD, Vice Chair, Winthrop Board of Health	Air Quality	I would also welcome a new and comprehensive, independent health report specifically in these close proximity communities, which includes data gathered from local hospitals and physicians regarding chronic respiratory diseases in children and adults.	Massport partners with other agencies and departments to monitor and report on community health in close proximity to Logan Airport. The *2017 Environmental Status and Planning Report (ESPR)* provides updates on the activity levels at Logan Airport which play a direct role in the air quality in adjacent communities. Massport provides an update on the status and findings of the MassDPH Logan Airport Health Study and Massport's air quality studies in the annual Environmental Data Reports (EDRs) and ESPRs. The latest update on the health study is provided in Chapter 7, *Air Quality/Emissions Reduction.* The results of the health studies are also available online at: http://www.mass.gov/eohhs/docs/dph/environmental/investigations/logan/logan-airport-health-study-final.pdf. Massport will support and closely follow the findings of research studies required under the FAA Reauthorization Act of 2018. Specific studies of interest include evaluation of an alternative airplane noise metric; assessment of lead in aviation gasoline and mitigation to reduce ambient lead concentrations; analysis of the relationship between jet aircraft approach and takeoff speeds and corresponding noise impacts on surrounding communities; review of relationship between aircraft noise exposure and its effects on communities around airports; and the study of potential health and economic impacts of overflight noise (which includes Boston as a case study). The FAA Reauthorization Act of 2018 includes required consideration of community noise concerns particularly when relating to a new RNAV departure procedure over noise sensitive areas, and also calls for community involvement in FAA NextGen projects located in metroplexes. See https://www.congress.gov/bill/115th-congress/house-bill/4/text for additional information.
3-3	Astrid Weins, MD, PhD, Vice Chair, Winthrop Board of Health	Community Engagement	I wish that in coming years, the most affected communities, such as East Boston and Winthrop, will receive more detailed information about air and noise pollution in general in a more timely fashion.	Massport engages directly with the surrounding communities on noise and other issues through the Massport Community Advisory Committee (CAC). Massport works to deliver timely and transparent reports about airport related impacts, specifically air and noise pollution. Massport also seeks to engage the public on projects to provide information and gather feedback. Massport prepares EDRs and ESPRs annually and is one of the only airports in the nation to provide such a report. The reports provide detailed information on air quality and noise conditions. Massport holds a public meeting each year to review findings of the report and discuss comments and questions from the community. Massport publishes the EDRs and ESPRs, along with project-specific environmental documents, on Massport's website.

This Page Intentionally Left Blank.

July 31, 2018

The Honorable Matthew Beaton, Secretary
Executive Office of Energy and Environmental Affairs
Attention: MEPA Office EEA #3247
100 Cambridge Street, Suite 900
Boston, MA 02114

Re: Boston-Logan International Airport 2017 EDR

Dear Secretary Beaton:

As members of the Winthrop Airport Hazards Committee and residents who live within meters of the runways, we are grateful for this opportunity to submit comments on the Boston-Logan International Airport 2017 Environmental Data Report (EDR). We appreciate MassPort's stated commitments to environmental sustainability and climate resilience and hope that our feedback and concerns are considered.

As noted in the EDR, Logan Airport is the 17th busiest US commercial airport by passengers and 18th by aircraft movement is one of the fastest growing major U. S. airports in terms of number of passengers over the past five years. The total number of air passengers increased by 8.5% to 36.3 million in 2016, compared to 33.4 million in 2015. In addition, the number of aircraft operations increased from 363,797 in 2014 to 372,930 in 2015 to 391,222 in 2016, a 4.9 percent increase. We have noticed some discrepancies in the numbers that have been presented in the EDR versus in the flight activity data that is provided to residents who file complaints and hope that this can be clarified.

Mitigation
We appreciate that the EDR includes explicit "commitment to mitigation". As an immediately neighboring community, we would like to request that this mitigation include additional soundproofing for homes in our community, particularly those that never received initial soundproofing but are now exposed to excessive aircraft noise as a result of RNAV determined flight paths.

Monitoring
There is a gap between how the EDR presents its data and how people in Winthrop are actually being affected. We need ground based noise and air pollution monitoring to effectively measure the impact that the airport is having on our health and environment. This is not reflected in the EDR.

Outreach
While we are appreciative of the extended public comment period for this report, we strongly encourage you to make a concerted effort to get this critical information into the hands of the

people who are most impacted by it by hosting multiple public meetings and holding them in the neighboring communities themselves. One public meeting at Logan Airport is not sufficient.

Environmental Impacts

Most of the EDR's Executive Summary speaks to Logan's operations and the Massachusetts economy. Further, 13 of 47 pages are dedicated to non-environmental impacts of the airport. We respectfully ask that the Environmental Data Report focus more explicitly on exactly that-environmental impacts of what has increasingly become non-stop flight operations at an urban airport.

Ground Access and Parking Project

We have concerns about the Logan Airport Parking Project Proposal to build up to 5,000 new on-airport commercial parking spaces and its effect on the environment and the Winthrop and East Boston communities. This may affect the efforts to increase the use of High Occupancy Vehicles (HOVs), transit, and shared-ride options for travel to and from the airport and to minimize vehicle trips. During the period from 2014 to 2015, Vehicle Miles Traveled (VMT) on-airport increased by 6.5 percent. We recognize that TNC generated trips are too new to be considered for trends and are glad that plans to build these parking garages have not yet been pursued as a result of the dramatic impact on passenger travel that these ride hailing services have yielded in the last year. The Conservation Law Foundation (CLF) provided a number of powerful mitigation strategies (such as increasing service on Logan Express, electrifying ground fleet, etc) that we hope will be pursued whether or not this parking lot is built.

Noise Abatement

The EDR confirms the widespread perception in Winthrop that airport noise and night time operations are in fact increasing. The overall number of people exposed to Day-Night Average Sound Level (DNL) values greater than or equal to 65 decibels (dB) rose 20.5 percent from 14,097 people in 2015 to 16,985 people in 2016. DNL exposure levels above 65 dB are considered to be incompatible with residential land use. Runway use changes from 2015 to 2016 were the largest factor in the increase in the number of people exposed to DNL values greater than or equal to 65 dB in 2016. There was an overall increase in nighttime operations of more than 9 percent in 2016 compared to 2015.

We echo Bill Schmidt of the Winthrop Board of Health in his concern that increased departures from Runways 9 and 27, and increased nighttime arrivals have resulted in increased noise levels in Winthrop. The number of people exposed to noise levels of 65dB or greater in Winthrop increased by over 300 between 2015 and 2016, from 2,943 to 3,292 people. The exposure was most pronounced in the Point Shirley and Court Road areas.

Air Quality/Emissions Reduction

While increased noise is both a nuisance and a public health hazard, we are particularly concerned about the detrimental effects of air pollution caused by airport and flight operations. In 2016, calculated emissions of Volatile Organic Compounds (VOCs), Oxides to Nitrogen (NOx), Carbon Monoxide (CO), and Particulate Matter (PM) went up compared to 2015. The

Increase in emissions for VOCs, NOx, CO and PM are primarily due to the corresponding increase in Aircraft Landing and Take-Offs (LTOs). Efforts to reduce airfield taxi times should be a priority. In 2016, total Greenhouse Gas Emissions (GHG) grew by 2.8 percent over 2015.

We appreciate the MEPA office's consideration of these concerns and look forward to your efforts to address them.

Sincerely,

Dawn Quirk
Julia Wallerce
Members, Winthrop Airport Hazards Committee
Residents of Winthrop

This Page Intentionally Left Blank.

Comment #	Author	Topic	Comment	Response
4-1	Dawn Quirk and Julia Wallerce, Winthrop Airport Hazards Committee	Noise / Mitigation	We would like to request that this mitigation include additional soundproofing for homes in our community, particularly those that never received initial soundproofing but are now exposed to excessive aircraft noise as a result of RNAV determined flight paths.	Massport must follow Federal Aviation Administration (FAA) guidelines on soundproofing eligibility. Noise contours of specific day-night average sound levels (DNL) are formulated using the FAA's Aviation Environmental Design Tool (AEDT) model and the FAA abides by a national noise standard of DNL 65 dB or greater. If a residence is located outside the DNL 65 dB contour it is not eligible for the residential sound insulation program (RSIP). To date, Massport has sound insulated 36 schools and 11,515 residential dwelling units.
4-2	Dawn Quirk and Julia Wallerce, Winthrop Airport Hazards Committee	Noise / Air Quality	There is a gap between how the EDR presents its data and how people in Winthrop are actually being affected. We need ground based noise and air pollution monitoring to effectively measure the impact that the airport is having on our health and environment. This is not reflected in the EDR.	Massport follows FAA guidelines on reporting noise and air quality emissions. There are five permanent noise monitors in Winthrop (sites 4 through 8).
4-3	Dawn Quirk and Julia Wallerce, Winthrop Airport Hazards Committee	Community Engagement	While we are appreciative of the extended public comment period for this report, we strongly encourage you to make a concerted effort to get this critical information into the hands of the people who are most impacted by it by hosting multiple public meetings and holding them in the neighboring communities themselves. One public meeting at Logan Airport is not sufficient.	The extended public comment period afforded the public the opportunity to submit comments on the *2016 Environmental Data Report (EDR)* and is anticipated for the *2017 Environmental Status and Planning Report (ESPR).* Massport continually looks for ways to increase knowledge sharing and public outreach to the neighboring communities, both online and in-person.
4-4	Dawn Quirk and Julia Wallerce, Winthrop Airport Hazards Committee	Content/ Environmental Impacts	Further, 13 of 47 pages are dedicated to non-environmental impacts of the airport. We respectfully ask that the Environmental Data Report focus more explicitly on exactly that-environmental impacts of what has increasingly become non-stop flight operations at an urban airport.	The discussion of economic growth, regional transportation, and activity levels is important to set the context for the environmentally-focused chapters. This background explains the operational changes that Logan Airport is experiencing, as well as how the economy is impacting its growth. Additionally, this information helps in evaluating future conditions, which is an important component of the *2017 ESPR* .
4-5	Dawn Quirk and Julia Wallerce, Winthrop Airport Hazards Committee	Mitigation	The Conservation Law Foundation (CLF) provided a number of powerful mitigation strategies (such as increasing service on Logan Express, electrifying ground fleet, etc.) that we hope will be pursued whether or not this parking lot is built.	The *2017 ESPR* reports on projects that are planned, designed, and implemented at Logan Airport, including the Logan Airport Parking Project, in Chapter 3, *Airport Planning.* Specific mitigation commitments associated with the Logan Airport Parking Project can be found on Massport's website at http://www.massport.com/massport/about-massport/project-environmental-filings/logan-airport/. Strategies to enhance service at Logan Airport and reduce environmental impacts are important to Massport and are discussed throughout the chapters in the *2017 ESPR* . The *2017 ESPR* continues to report on cumulative, Airport-wide environmental impacts on air quality, noise, and water quality in the applicable chapters. The chapter also provides a summary of beneficial measures implemented by Massport that are not tied to project-specific mitigation. Massport promotes numerous high-occupancy vehicle (HOV), transit, and shared ride options to improve on Airport roadway and curbside operations, alleviate constraints on parking, and improve customer service. Key initiatives include: - A goal to double Logan Express ridership by expanding services and facilities; - Studies to improve ridership; - Expansion of services; - Evaluating new suburban Logan Express locations - A plan to purchase eight additional Massachusetts Bay Transportation Authority (MBTA) Silver Line buses, increasing the fleet size purchased by Massport to 16 buses; and - Implementation of a transportation network company (TNC, such as Uber and Lyft) management plan to reduce congestion on-Airport, including a focus on ride rematch and shared-ride. Other initiatives are being considered and can be found in Chapter 5, *Ground Access to and from Logan Airport.*
4-6	Dawn Quirk and Julia Wallerce, Winthrop Airport Hazards Committee	Air Quality	Efforts to reduce airfield taxi times should be a priority.	Single Engine taxiing is one measure that is being used by air carriers to help reduce fuel use and emissions. Massport supports single engine taxiing when it can be done safely, voluntarily, and at the discretion of the pilot. Using the MIT methodology and available data applied to 2017 aircraft operational data for Logan Airport, the results show a savings of 1,820,261 gallons of jet fuel and the reduction of approximately 17,910 metric tons of greenhouse gas (GHG) emissions.

This Page Intentionally Left Blank.

From: Peter Houk
To: Canaday, Anne (EEA)
Subject: Houk comments (Medford MCAC) on 2016 EDR
Date: Monday, July 02, 2018 3:54:29 PM
Attachments: HOUK comments EDR2016.docx

Anne,
I was at the EDR meeting at Massport a few weeks ago. Please find attached my comments and questions, and please let me know they were received,
Thanks,
Peter

Peter Houk
Medford Representative
Massport Community Advisory Committee

Matthew Beaton, Secretary
Executive Office of Energy and Environmental Affairs
Attn: MEPA Office
Anne Canaday, EEA No 3247
100 Cambridge Street, Suite 900
Boston, MA 02114

Dear Mr. Beaton, Anne Canaday, and MEPA,
Herein are contained my comments regarding the recently published 2016 Logan Environmental Data Report (EDR) by Massport.

I represent the city of Medford on the Massport Community Advisory Committee (MCAC and so have a special interest in the impact of aircraft noise on our city. I have lived in tl same house in the city of Medford for 19 years. In the last decade or so, the impact of aircraft noise on the city of Medford has increased quite dramatically. Between a permanent **threefold** increase in the use of runway 33L for jet departures starting in 20C followed by the FAA's 2013 concentration of flight paths into RNAV routes that narrowly funnel 33L traffic through the entire length of Medford, combined with an increase in late night use of 33L for international flights, Medford has seen profound change with respec to airplane noise, and not for the better. In fact, the 2016 EDR shows a 50% increase in number of complainants and a more than a 300% increase in number of complaints filec with Massport between 2015 and 2016. This complaint data alone clearly shows a patte that cannot and should not be ignored.

The message is that RNAV has serious negative impacts when implemented over residential neighborhoods, for the simple reason that it exposes a relatively few number citizens to a disproportionate amount of aircraft noise, often for many hours on end. Despite the fact that no part of Medford is within the 65 DNL footprint, many citizens, especially those under the flight paths, have become sensitized to repetitive aircraft nois since the implementation of RNAV. I hear from such people almost every day, from residents who have lived in Medford for 5 years or for 50 years.
Another equally important message is that the incursion of airplane noise into the night hours has expanded to unprecedented and unacceptable levels. Since the expansion of Terminal E and the addition of several international routes, I have been getting calls fror people all over the city who are complain to me about being woken up at all hours of the night by jets flying over their homes. The frequency of this kind of complaint is new and troubling. Your own data in the EDR shows this trend going in the wrong direction: a 9.3 increase between 2015 and 2016 in nighttime operations.

My complaints about the 2016 EDR, both general and specific, address the ways in whi(the data presented hides realities that affect my city. For example:

1. **Types of planes**: The EDR goes to great lengths to convey the message that, in general, aircraft are quieter than ever before. What is also true, is that larger jets have steadily replaced smaller regional jets and prop planes (see figure 2-7), resulting in RNAV-affected areas actually seeing an *increase* in louder and lower planes. When you live under a RNAV path you don't hear *some* of the planes – yc hear *all* of the planes, and it seems like the planes are lower than ever because y(are hearing *every* jet, including the lowest ones.
2. **On nighttime departures using 33L:** Several times in the EDR (eg page 6-13) it stated that runway 15R is the preferred runway for nighttime departures. Nowhere in the EDR are included statistics about non-compliance with the nighttime procedure. The procedure is violated frequently. In fact, for example, Cathay Paci flight 811, which departs Logan seven times per week at **1:45AM** failed, in 2017, t comply with the nighttime procedure between 7% and 25% of the time on a montr basis, and instead used 33L, flying over residential neighborhoods. Will Massport please publish official figures about how often the nighttime procedure is violated on this runway? It only takes ONE very loud, very low, jet to wake a person, so a 10dB penalty is meaningless when it comes to sleep interruption.
   The EDR is misleading about the degree to which nighttime flights using 33L have increased and are encroaching into hours when citizens should be sleeping. For example, just this last Friday and Saturday, June 29-30, there were four large and low (when I say low, I mean below 2500' crossing I-93, about 8 miles from the airfield) departures off of 33L within 15 minutes on either side of midnight: 11:58 PM, THY82M; 12:00, NAX7150; 12:05, AMX699; 12:09, JBU61. This was followe(by the Cathay Pacific CPA811 flight to Hong Kong at 2:15AM, and by AA flight 2527 at 5:13AM. That's essentially one two hour window for sleep followed by a three hour window, at best. This is not acceptable. I realize that the FAA controls carriers and scheduling at Massport, but Massport should not be a party to expansion of air traffic into the nighttime hours such that entire communities are deprived of sleep. This is a serious health consideration, and the FAA needs to work with Massport to curtail flights during these late hours, since it is clear that th 15R noise abatement procedure is, and cannot realistically be, used a significant enough amount of the time.
3. **On runway use and PRAS**. The EDR states that PRAS was discontinued, but remains a benchmark. Can you please state definitively whether PRAS, or some version of PRAS, actually informs the choice of runway configurations at Logan, o whether it does not? If not, are decisions about runway choice at Logan currently based solely on weather conditions and volume?

4. **On RNAV concentration and Medford.** I have already stated that RNAV concentration has adversely affected Medford (supported by all kinds of complain data and shown also in the increase in dB level seen in tables 6-13, 6-14, etc), an that the increase in nighttime operations only exacerbates this problem for the populace living under the flight paths. I'm happy to see that the MIT RNAV Studie: are referred to in 6-65 in the EDR, but not happy to see no explicit reference to dispersion of flight paths as an alternative. The only solution that will work to RNA concentration, is **de-concentration**. The FAA needs to model solutions that resemble the Logan Six departure scheme that was used prior to 2013. Funneling all air traffic through one town to the exclusion of others is not fair and not acceptable.

Comment #	Author	Topic	Comment	Response
5-1	Peter Houk, Medford Representative, Massport Community Advisory Committee	Noise	Will Massport please publish official figures about how often the nighttime procedure is violated on this runway [33L]?	Table H-5a (in the noise appendix of each Environmental Data Report [EDR]/Environmental Status and Planning Report [ESPR] document) provides detailed runway use, broken down by aircraft groupings and separated by arrival/departure and by day/night. Nighttime (10:00 PM to 7:00 AM) noise abatement procedures are based on wind and weather for safety reasons.
5-2	Peter Houk, Medford Representative, Massport Community Advisory Committee	Noise	I realize that the FAA controls carriers and scheduling at Massport, but Massport should not be a party to expansion of air traffic into the nighttime hours such that entire communities are deprived of sleep. This is a serious health consideration, and the FAA needs to work with Massport to curtail flights during these late hours, since it is clear that the 15R noise abatement procedure is, and cannot realistically be, used a significant enough amount of the time.	Any new access restrictions to Logan Airport are prohibited by current federal law. Massport actively promotes the late night use of Runway 15R for over-water departures and Runway 33L for arrivals, as wind and weather conditions allow. Massport will continue to work with Medford, and other communities, through the Massport Community Advisory Committee (CAC). The appropriate forum for further noise issues and discussions continues to be through the Massport CAC.
5-3	Peter Houk, Medford Representative, Massport Community Advisory Committee	Noise	The EDR states that PRAS was discontinued, but remains a benchmark. Can you please state definitively whether PRAS, or some version of PRAS, actually informs the choice of runway configurations at Logan, or whether it does not? If not, are decisions about runway choice at Logan currently based solely on weather conditions and volume?	The Preferential Runway Advisory System (PRAS) is no longer in use and does not inform the choice of runway configurations. The choice of runway configurations by the Federal Aviation Administration (FAA) at Logan Airport is primarily driven by weather, available runways, and current and forecasted volume.
5-4	Peter Houk, Medford Representative, Massport Community Advisory Committee	Noise	I'm happy to see that the MIT RNAV Studies are referred to in 6-65 in the EDR, but not happy to see no explicit reference to dispersion of flight paths as an alternative. The only solution that will work to RNAV concentration, is de-concentration. The FAA needs to model solutions that resemble the Logan Six departure scheme that was used prior to 2013. Funneling all air traffic through one town to the exclusion of others is not fair and not acceptable.	The RNAV study is currently evaluating dispersion of flight tracks as part of the Block 2 analysis. Regular updates are being provided to the Massport CAC and additional details can be found in Chapter 6, *Noise Abatement*. This work is ongoing and progress will continue to be reported in future EDR/ESPRs.

This Page Intentionally Left Blank.

July 31, 2018
Secretary Matthew Beaton
Executive Office of Environmental Affairs
Attn: Anne Canaday, EEA No. 3247
100 Cambridge Street, Suite 900
Boston, Ma. 02114

RE: EEA No. 3247

Dear Secretary Beaton,
I am writing to submit comment on EEA No. 3247, the Environmental Data Report (EDR) 2016 on behalf of Airport Impact Relief, Incorporated (AIR, Inc.).

EDR 2016 data further validate our growing concern which is shared by residents across all social, economic and cultural strata in the Commonwealth over airport health impacts by documenting growing noise, traffic congestion and emissions as the airport expands. Evidence provided in this comment letter demonstrates that airport traffic congestion, pollution and noise threatens public health, and dampens economic growth. Therefore:

1. *We are requesting that EOEA / DEP acknowledge the correlations, found in multiple studies and in particular in the research file labeled 'Hudda Chelsea 2018' in the folder linked above, between the reported airport passenger and commercial operational year to year growth between 2011 and 2016 and increases in noise, traffic congestion and emissions as reported in the 2016 EDR; and that EOEA / DEP provide in the Certification notice for EEA 3247, EOEA's disposition regarding regulation, measurement and reduction activities of current and anticipated levels given the Massachusetts Port Authority's present uncontrolled growth and the agency's plans and projections of continued growth in operations into the future.*

With 5 consecutive years of EDR and ESPR reporting increasing environmental impacts, we believe DEP refusal to review project-related impacts during the environmental review processes associated with airport expansion projects acts to suppress public comment, allowing Massachusetts Port Authority (Massport, or the Authority) to circumvent the intended purpose of the MEPA environmental review processes.

While citizen involvement is understood to be a key factor in the successful administration of environmental policy, the timing and structure of the MEPA environmental review process for airport projects and reports is clearly not conducive to citizen engagement. Releasing a 1,000 page technical document at the beginning of the summer and providing a 30 day period in which citizens are expected to read, study, analyze, and comment on dense, technical data is not an accepted best practice in environmental justice, nor expected to produce effective engagement. This 'single period comment procedure' provides no opportunity for interaction between the project proponent and community stakeholders. Without ongoing discussion, debate and negotiation, the MEPA process is artificially limited and the possibility of partnership and progress removed. We believe the MEPA comment system structurally denies the citizens of the Commonwealth due process.

2. *We call on EOEA to break the cycle of failure in environmental planning at Massport by taking action to improve community engagement in the EDR writing and release process. We are requesting that DEP and EOEA engage AIR, Inc., GreenRoots, Conservation Law Foundation (CLF),*

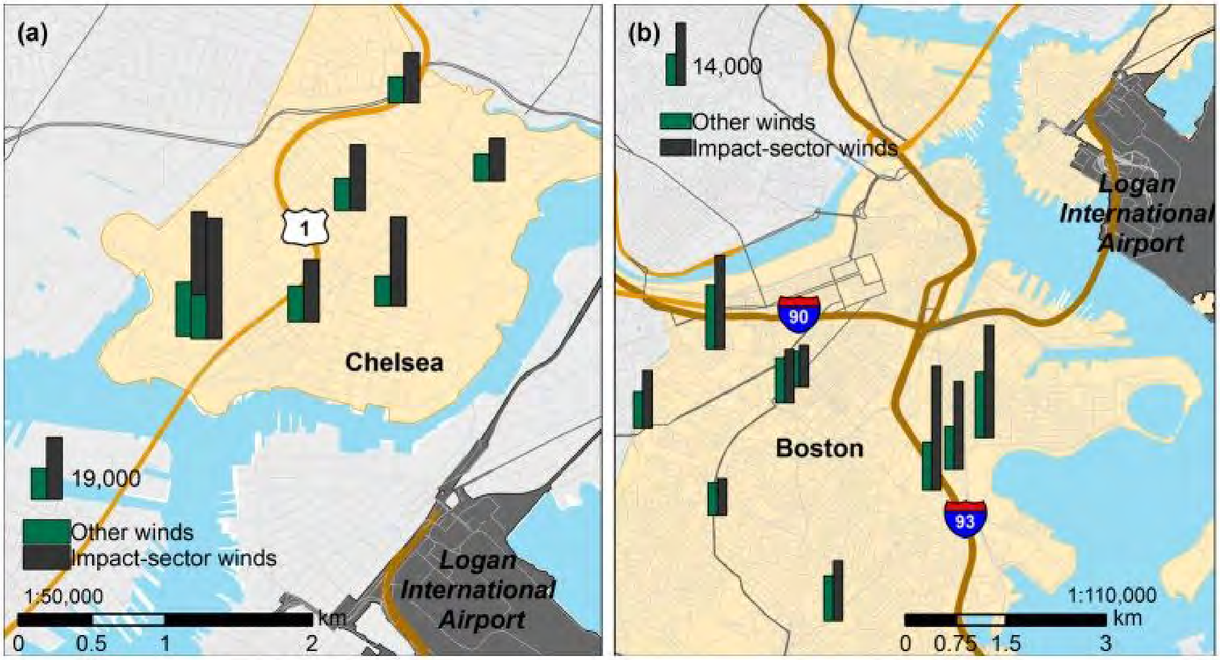
Action for Community and Environment (ACE) directly, starting immediately in development of a Rolling Environmental Review which would build opportunity for partnership between environmental justice communities in Boston, the Port Authority, and DEP in the improvement of the MEPA environmental review process as it relates to airport planning. Such collaboration would create vast improvements in delivery of environmental justice, as well as in the quality and effectiveness of airport environmental reports and plans.

While extensive in length, the EDR 2016 insufficiently addresses airport impacts in a comprehensive manner. By reporting ground access, emissions, operational level, and noise data separately and without reference to the known environmental health impacts and costs of these activities, EDR 2016 *separates discussion of interdependent impacts into disjointed narratives*. This reduces Public understanding of the relationship between ground access policy and emissions, for example.

EDR 2016 offers an incomplete basis for public dialogue on the range of airport policy options, industry trends, and current innovations available to reduce cumulative impacts. Failure to provide discussion of industry best practices leaves EDR 2016 with one-sided analyses based on pro-growth, pro-proponent project data, which falls far short of producing a comprehensive reporting of airport environmental impacts. EDR 2016 is further hampered by biased underpinnings: that airports create economic benefit with which regulation and innovation will interfere; that increasing airport efficiency produces environmental benefit, and; that airport administrations are passive players in demand-driven impact growth. Without acknowledgement that airport operations create socialized costs and losses which are absorbed across the region by the non-traveling public, of the existence of effective noise abatement and emissions reduction strategies such as night curfews or the option of reducing operations at Logan through collaboration with regional airports, or the fact that Massport can take a far more active role in managing demand, providing alternative services and creating incentives for desired outcomes, Massport fails to provide a credible effort at nurturing comprehension or to develop an effective base level of knowledge needed to support analysis of the environmental conditions at Logan.

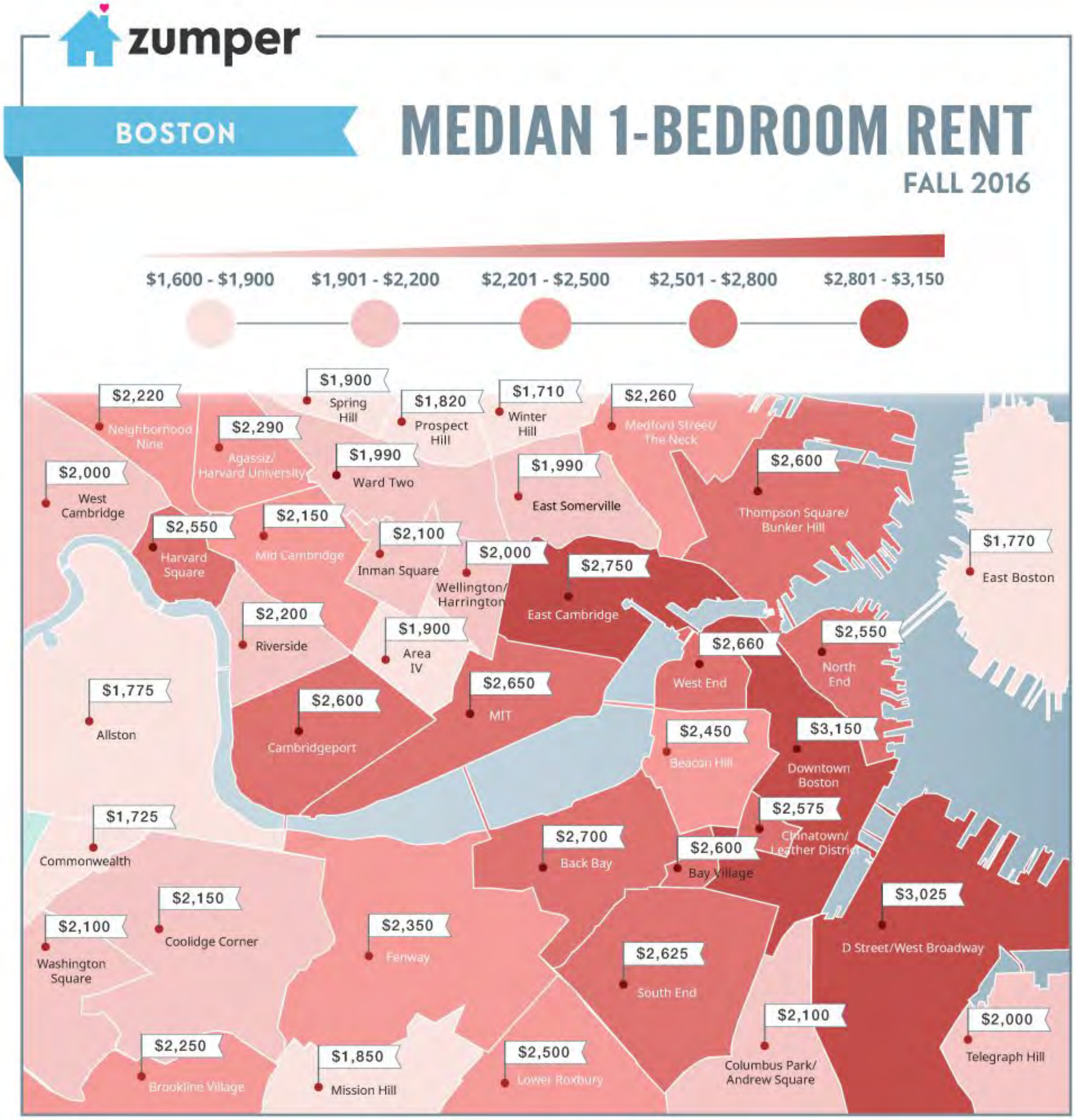
3. *We ask that the Secretary acknowledge in the his Certification Documentation the lack of comprehensive review and discussion of the existence of the practice of restricting nighttime operations which is used in Europe, and the failure of the EDR to present information regarding the potential benefits of similar nighttime flight restriction policies at Logan.*

EDR 2016 fails to incorporate comprehensive information on the social and economic costs of airport operations such as the costs of healthcare for children with Asthma, COPD, increased rates of heart disease, early cognitive decline, autism, hypertension, sleep interruption, and many other chronic diseases attributed to ground access and aviation emissions, or the growing costs of lost productivity across the region as Port Authority policies drive traffic congestion trends higher.



Regarding public health, EDR 2016 narratives explain that Massport has: made funding commitments to increase availability of screening for Asthma and Chronic Obstructive Pulmonary Disease (COPD) prevention and treatment in East Boston and Winthrop; entered into an agreement to evaluate and assess Asthma and COPD programs in North End, Charlestown, Chelsea, and South Boston, East Boston and Winthrop, and; agreed to work with DPH to expand Asthma and COPD prevention and treatment programs in South Boston, the North End, Chelsea, and Charlestown. However, while providing one paragraph of narrative background on the Logan Airport Health Study commissioned by DPH in 2004, EDR 2016 fails to report on volumes of recent and ongoing epidemiological and air quality research underway at top academic research universities such as Boston University School of Public Health and Tufts, which definitively conclude that local densely populated residential communities are being exposed to sharply elevated levels of UFP's, NOx, and other airport air pollutants known to cause serious chronic diseases.

In its failure to provide discussion of the state of scientific knowledge about the health impacts of airport emissions, EDR 2016 fails to provide the necessary data and information to prepare readers to form well-founded vision for change.



EDR 2016 fails to provide data or discussion of the broader economic costs of airport noise, traffic and pollution. Above and beyond the costs of health impacts produced by airport noise, traffic and pollution, numerous private and public real estate agencies and organizations report sharply reduced property values and rent levels in airport impacted communities in the Boston region. These data indicate a clear reduction in real estate values in East Boston which can be explained by the community's high level of airport impacts. For example, assuming a conservative $500 average rental discount due to negative market perceptions of airport impacts in East Boston, monthly lost rent over 7,000 rental units is $3.5 million. Under this scenario, annual lost rent would be $42 million, in East Boston alone. At a $200,000 per sale discount, a total annual real estate sales level of 50 market-rate sales in East Boston would result in a $10 million dollar reduction in economic activity. Further analysis

is needed to understand the airport's impact on rents and real estate sales prices across the broader region, but regional economic losses throughout East Boston, Winthrop, Chelsea, Revere, and now increasingly in suburban communities such as Milton, Medford and Malden are significant and would easily reach into the 100's of millions in lost rental income and reduced sales prices. Yet, nowhere in EDR 2016 are such negative economic or quality of life impacts measured, discussed or analyzed.

4. *We ask that the Secretary acknowledge, in his Certificate for EEA 3247, the lack of comprehensive data provided on the range of economic costs of airport operations in EDR 2016, and; that Massport be required to provide supplemental data on these important costs of the cumulative impacts of Boston Logan airport as an addendum to EDR 2016.* Such analyses should be required in all upcoming EDR and ESPR.

Regarding emissions: EDR reports rely on modelled annual average emissions data exclusively. These data offer only limited value to stakeholders wishing to understand air quality and health impacts of Logan Airport, at their home locations, and over time. Advancements are being made in air quality monitoring which allow for networked monitoring systems which can provide real-time reporting on emissions and air quality. AIR, Inc. is sponsoring the development of a first-of-its-kind system (the System) in partnership with Aerodyne Research, Inc. and Olin College of Engineering (the Partnership). Through this collaboration, AIR, Inc., Aerodyne, and Olin will produce a real-time, networked reporting System by locating a series of new, lower cost ARISense air quality monitors (developed by Aerodyne) in East Boston and Winthrop and networking them together to provide citizens with current air quality information via mobile applications. This data will be useful in assisting near airport community residents in developing *emissions avoidance behaviors,* and affecting measurable health outcome improvements over time. Such innovations are the byproduct of community, academic, and private sector collaborations in which Massport shows no interest.

5. *We ask that the Secretary require Massport, as a condition of his Certification document, to produce supplemental review and analyses of ongoing air quality measurement practices, techniques and innovations including specifically, the ARISense collaboration, and that the Port Authority be required under the same condition to engage with AIR, Inc. and its partners, assess the System's capabilities, provide a brief report on such capabilities, and include in this report the agency's disposition toward joining in this Partnership.*

EDR 2016 provides extensive evidence that Massport understands the need to produce marketable options which assist air travelers in accessing Logan Airport through the use of passenger-class motorized vehicles. This report also provides repeated reference to consumer secondary transportation mode preferences reported in the 2016 Logan Airport Air Traveler Survey, under the hypothetical scenario that commercial parking were not available. However, EDR 2016 does not provide evidence that Massport has analyzed a wide range of pricing and positioning alternatives and innovations within the HOV Bus Rapid Transit and MBTA rail ground access modes. The EDR 2016 Certificate should include conditions that require:

6. *Analysis and reporting of changes in HOV mode share, parking demand, tunnel traffic, and air pollution which could be attained through expanded and improved Logan Express service.*

Massport should be required to model and or otherwise research the market share effect of adding a minimum of 5 additional locations with regular service (every 20 minutes) throughout metro-Boston region, creating a network of fast, convenient, clean and affordable HOV airport access at mass transit price points. Massport should be required to model and research the benefit of improving service by implementing best practices in Bus Rapid Transit (BRT) such as offering free WiFi and electronic ticketing while also maintaining prices of all express airport bus service expansions at the $5, (free with a valid MBTA pass) levels established prior to the implementation of increased pricing.

7. *Analysis and reporting of changes in HOV mode share, parking demand, tunnel traffic, and air pollution associated with a variety of <u>pricing disincentives</u> for passenger car airport ground access modes via increasing on-airport parking rates at Logan to position all forms of short-term airport parking (including in-garage, cell phone lot and curbside options) at higher price points than MBTA and Logan Express options.*

8. *Analysis and reporting of changes in HOV mode share, parking demand, tunnel traffic, and air pollution associated with <u>reducing suburban Logan Express Service price points</u> to attract a greater share of drop-off and pick up mode travelers.* This initiative would work in conjunction with increases in the cost structure of on-airport short term parking options.

9. *Analysis and reporting of changes in mass transit mode share increases, parking capacity, tunnel traffic, and air pollution attainable through corrections to the pricing of on-airport parking and Logan Express options, through improvement of the MBTA system, specifically through <u>development of a direct connection between the Red and Blue Lines, and extension of the Blue Line to Lynn.</u>*

Based on the success of the Back Bay Logan Express (BBLE), which piloted reduced-price HOV mode service extensions, the four above-listed HOV-related pricing and service adjustments can be expected to provide Massport with immediate opportunities to reduce traffic and ground transportation-related pollution on a year to year basis over the upcoming 2 – 3 year period. Based upon the mode share achieved in the BBLE pilot, the combination of these efforts could be expected to produce as much as a 10% increase in HOV mode share of ground transportation to Logan airport over the short term, helping Massport finally move toward, meet and exceed its multi-decades old goal of achieving 35% HOV mode share levels.

10. *Set caps on pollution, noise, and traffic at current levels. Massport has proven incapable of slowing expansion of these public-health-damaging impacts.*

11. *Require Massport to create specific year to year impact reduction target goals and to provide specific plans, supported by appropriate modeling and a robust public comment process developed specifically to engage the public (including in Environmental Justice Communities) in these plans.*

12. *Establish an enforcement plan to incentivize Massport to achieve their impact reduction targets*

13. *Require Massport to provide reporting and analyses on increases in traffic, noise and pollution <u>relative to recent historic low impact levels</u> to focus public and agency attention on the important need to reverse the alarming trends in the growth of negative impacts, in*

understanding trends in airport pollution, and to assist the public in assessing current policies' capacity to create the needed public health gains.

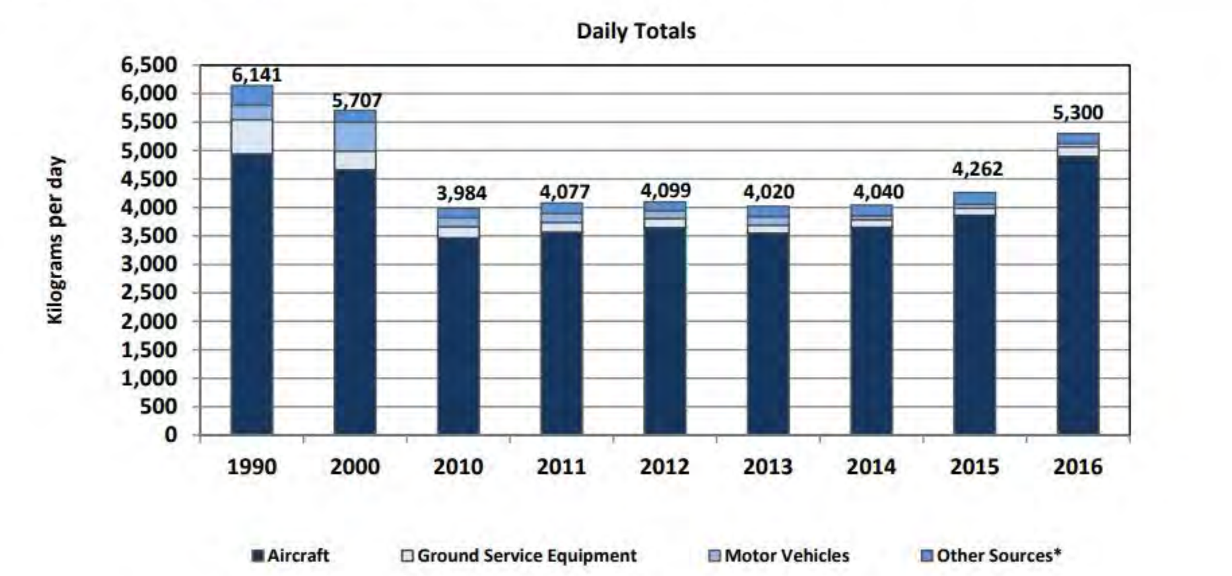
14. *The Secretary should require Massport to produce specific and credible plans to reduce passenger car modes of transportation through the harbor tunnels and improvement of mass transit travel modes to Logan.*

The EDR data reports that the 65DNL dB sound level, a noise energy level which HUD and FAA deem to be unacceptable for residential land land uses has expanded . To hold Massport accountable for Logan's noise impacts, this agency should be required to develop noise level modeling which reflects alternative operational levels inclusive of attainable shifts of flight operations to other viable New England airports, specifically including target off-loading goals to TF Green and Manchester Boston. Therefore:

15. *The Secretary should require Massport to model noise impacts at reduced operational levels in low, mid and high target reduction goal scenarios which could be achieved through aggressive diversion of flights to other New England airports, as well as reductions attainable through a night time noise curfew.*

Between 2015 and 2016 alone, VOC emissions are up 4.5%, NOx are up between 10.2% and 24.1%, depending on which model you use, and Particulate pollution is up 8.2%. Yet EDR 2016 reports that emissions are down.

Figure 7-3 Modeled Emissions of NO_X at Logan Airport, 1990, 2000, and 2010-2016



Source: Massport and KBE 2017.
Notes: * Other sources include stationary sources (e.g., Central Heating and Cooling Plant, snow melter usage, firefighter training, etc.). In 2016, aircraft-related emissions were calculated using AEDT.

The sum of the avoidable failures in environmental reporting, evaluation, and review process for airport activities at Logan International Airport creates an indelible stain on Massachusetts' environmental justice record. Massport, FAA, and the for-profit airline industry have been allowed to propagate

unchecked growth of commercial airport activity with severe regional environmental impacts on environmental justice communities, as well as across the metropolitan region. To restore the credibility of MEPA, EOEA's response to this EDR must set forward regulatory structure that will advance long-overdue transportation policy reforms, reverse negative health and quality of life trends in our communities (reported in the EDR), and correct Massport's organizational disregard for the health and safety of stakeholders on the ground.

16. *EOEA should require the Port Authority to convene a subset of community stakeholders including AIR, Inc., GreenRoots, Fair Skies Nation, Conservation Law Foundation, the Massport CAC, and other community stakeholder groups <u>mutually agreed upon via majority vote of this subset of groups</u>, as a 2016 Supplemental Environmental Reporting Task Force, in the development of a Supplemental EDR 2016 which will include accurate and easy to read representation of the level and causes of airport impacts; the range of policy alternatives, a comprehensive cataloguing of airport economic costs, and an assessment of available responses to slow the growth of emissions, traffic and noise.*

The work of this Task Force should be supported with adequate resources. With $669 million in revenues in 2017, and over a $250 million in cash reserves and a $2 billion net position, the Port Authority is in excellent financial condition to supply the needed resources to support these organizations throughout the duration of the Supplemental EDR 2016 Development Process. The Task Force should independent consultancy as needed and have access to the support staff, contractors, consultants, equipment and services necessary to support the proper implementation of an adequate Supplemental 2016 EDR.

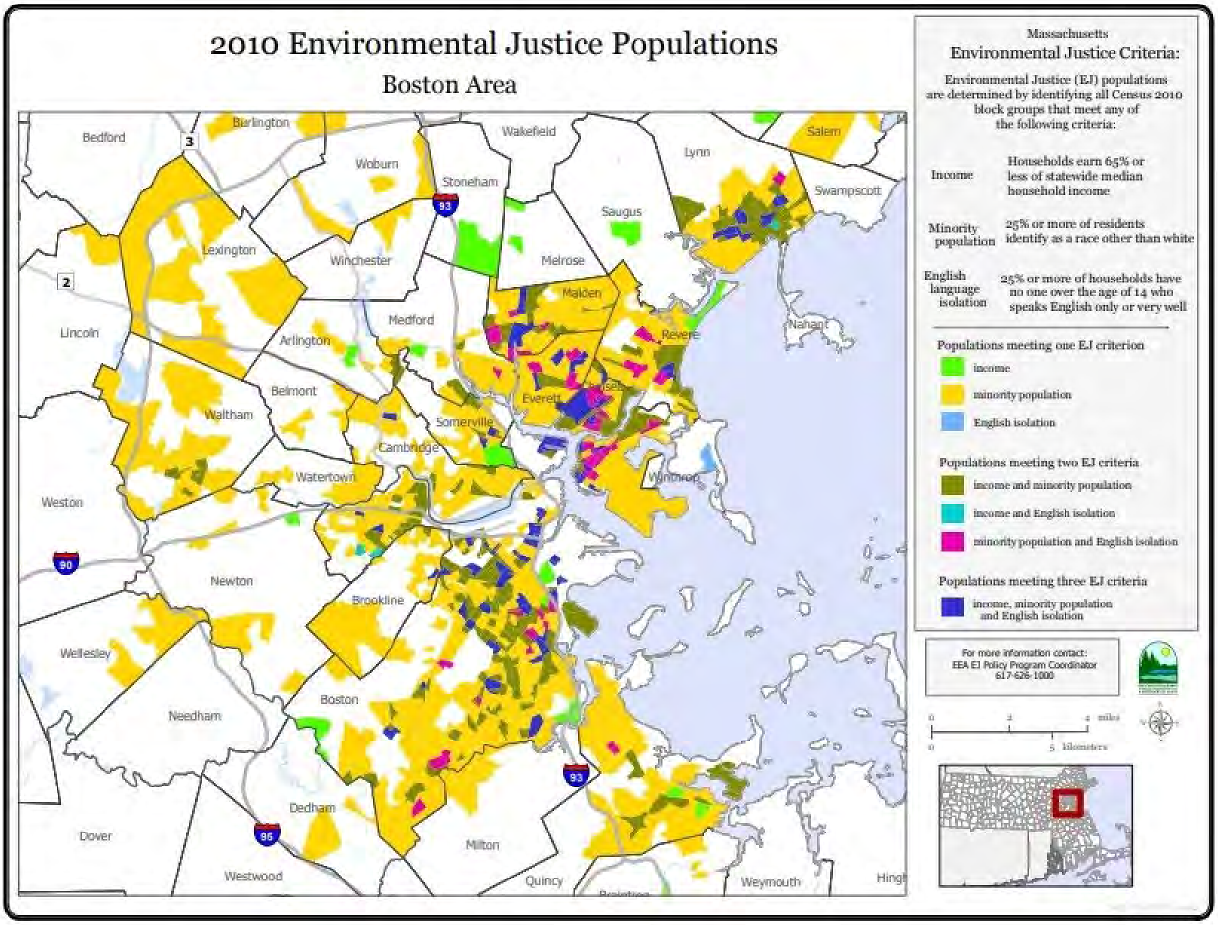
Although the omissions and inaccuracies in EDR 2016 are too numerous to address, attached are a series of Specific Examples of misleading and confusing narratives and data, included to accompany these comments and illustrate the damage done by Massport's poor performance in reporting on Logan's impacts. Please include these examples as part of our comments

Thank you for the opportunity to provide comment on this important topic. If you have any questions regarding AIR, Inc.'s comments, please contact me at gailmiller48@icloud.com.

Sincerely,

Gail C. Miller

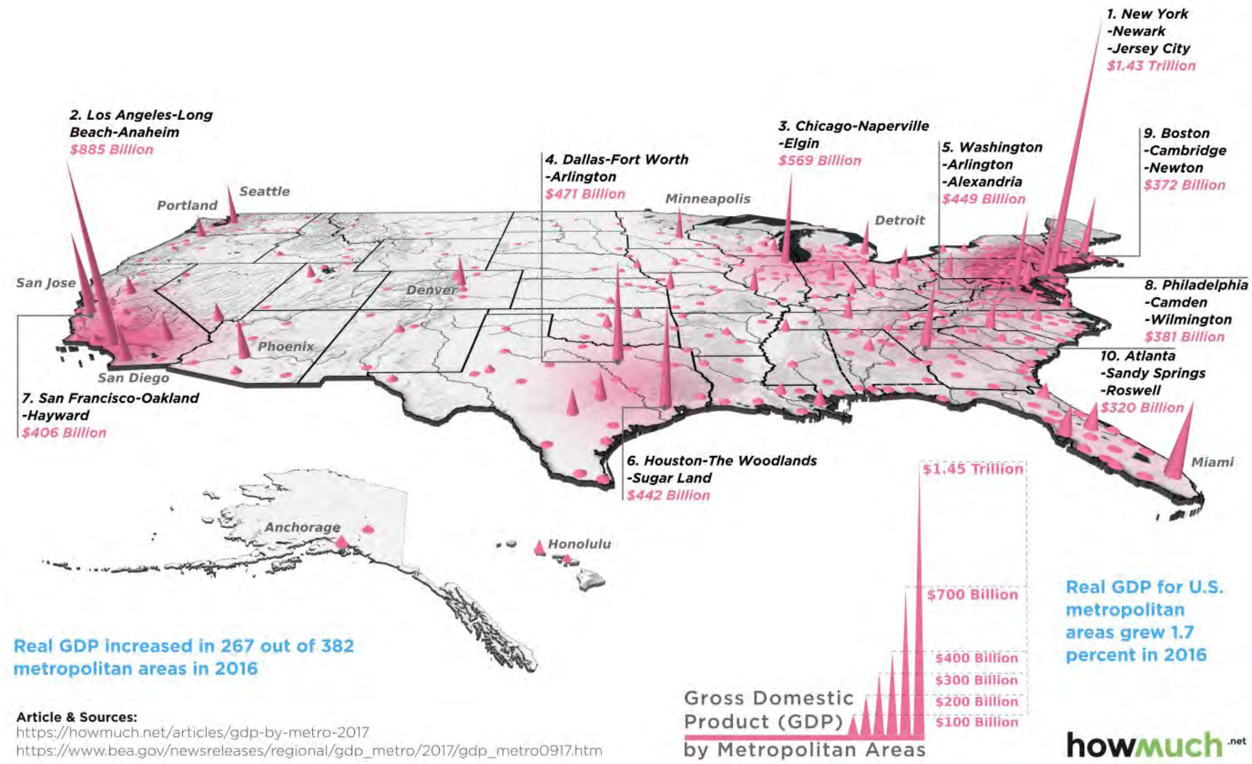
Gail Miller
President; Airport Impact Relief, Incorporated
395 Maverick Street
East Boston, Massachusetts 02128
gailmiller48@icloud.com



Specific Example One: Environmental Justice

EPA provides [guidance](#)which states that '...each agency should work to "ensure that public documents, notices, and hearings relating to human health or the environment are concise, understandable, and readily accessible to the public."' However, EDR 2016 fails to provide sufficient background information, educational content, review of industry best practices and innovations, and does not make even basic common sense adjustments in wording choices which would lead to better comprehension for low income and minority readers in environmental justice communities, as well as for general audiences.

By failing to provide comprehensive review of complex airport topics, Massachusetts citizenry are once again left completely in the dark. To improve Massport compliance with EJ reporting standards, we request that EOEA require Massport 1) conduct a thorough review of available EJ best practices guidance (example: https://www.fws.gov/environmental-justice/pdfs/nepa_promising_practices_document_2016.pdf), and 2) engage with EJ community groups (specifically including AIR, Inc., GreenRoots, and other groups mutually agreed-upon by these two local leadership EJ organizations) in creating a Supplemental Executive Summary which will incorporate best practices in EJ communications and result in an effective and productive dialogue regarding this document, the data it presents, and the policy choices it explains, with the intent to provide comprehensive educational benefit in EJ communities and beyond.



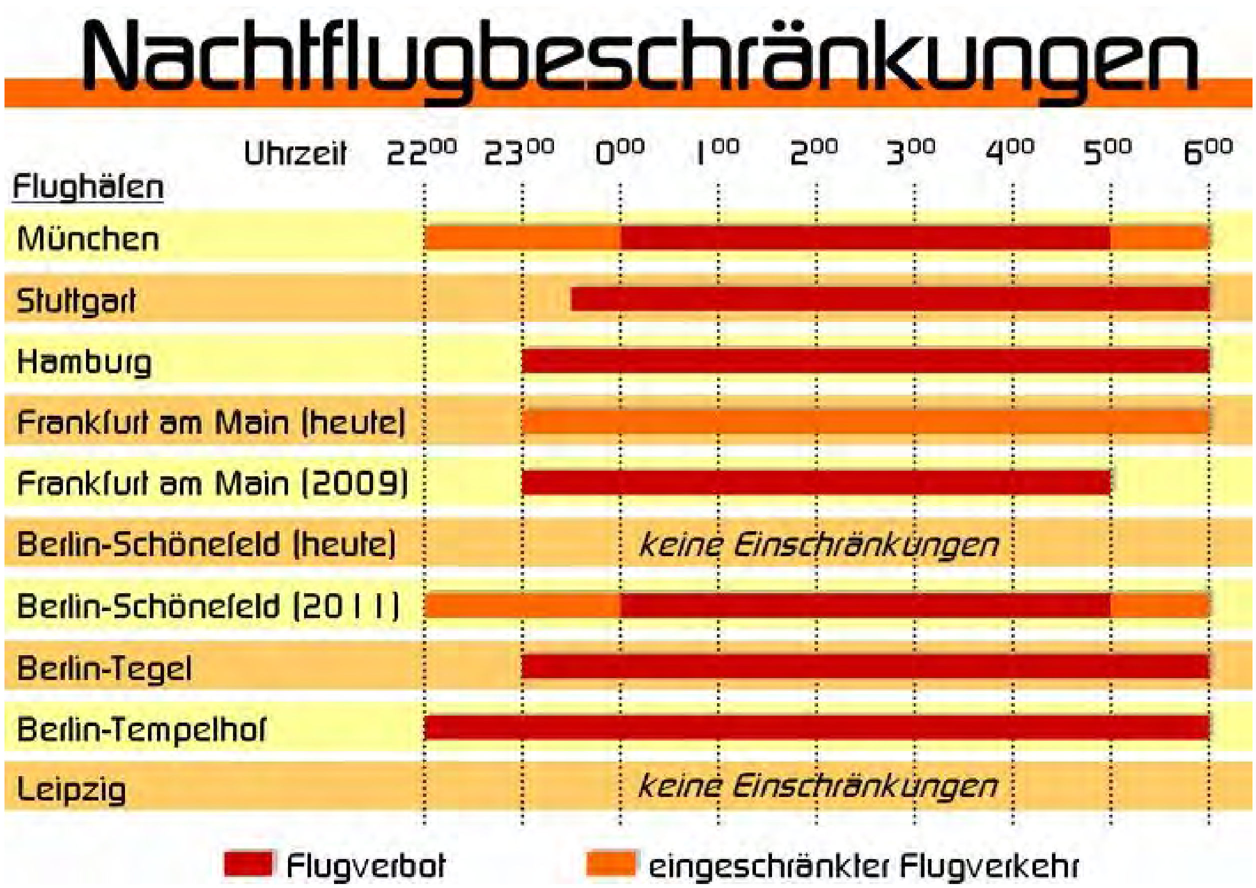
Specific Example Two: Unsubstantiated Claims

EDR 2016 claims that Logan Airport and the airport industry are a major economic driver in the state and region citing Massachusetts Statewide Airport Economic Impact Study Update, completed by MassDOT in 2014, which estimates that aviation contributes $16.6 billion in output to the Massachusetts economy annually (80.7 percent of which is due to Logan Airport).

EDR 2016 however FAILS to acknowledge that studies such as this have been widely discredited as inaccurate airport propaganda, basing estimates on induced and indirect benefits which are recklessly biased. The report arriving at these wild conclusions was prepared by CDM Smith with Airport Solutions Group, LLC. & Spotlight Communications, a group which listing airports and utility companies as their only clients. CDM Smith's conclusions would mean that Logan is responsible for 4.5% of all of the economic activity ($372 billion) in the combined Metropolitan Statistical Area from Manchester to Providence, from Boston to Worcester. This calculation does not incorporate the economic costs of ill health, missed work, real estate devaluation, or traffic congestion in metropolitan Boston, which alone is estimated to be cost over $5.7 Billion across the region.

Across the nation, consultants such as CDM Smith are using the same skewed formulas to provide airport clients and state transportation departments with similar reports: i.e.: Detroit; Louisville; San Francisco; Cleveland; Los Angeles None of these reports factor in the socialized costs.

Through reliance on biased, trade-friendly data and OMISSION of data regarding the social and economic costs of aviation impacts, EDR 2016 FAILS to provide comprehensive information about the economic impacts of aviation in Massachusetts.



Specific Example Three: Incomplete Narratives

EDR 2016 claims that foreign-based carriers including Air Berlin, Norwegian Air Shuttle, Qatar Airways, Scandinavian Airlines, and TAP Air Portugal are using cleaner and quieter wide-body aircraft to fly to new international destinations from Logan Airport, in 2016 including Dusseldorf, London Gatwick, Doha, Copenhagen, and Lisbon. Ironically, many of the new international destination trips to Boston begin at airports which enforce night flight restrictions and curfews. Duseldorf Airport for example, forbids nighttime operations, using a stepped system which restricts the noisiest operations between the hours of 6:00 PM and 7:00 AM, and all take-offs and landings between 10:00 PM and 5:00 AM. In another example, Frankfurt Hesse Airport put a nighttime flight ban on all flights into effect in 2011. While industry leaders warned of dire consequences, Frankfurt Airport has maintained its ranking as one of the world's busiest airports, and in fact has grown by 15% over this timeframe. Frankfurt Hesse Airport continues to be an innovator in noise abatement, while exhibiting strong and continued growth.

Frankfurt Airport Passenger Growth Trends		
YEAR	# PASSENGERS	% GROWTH
2011	56,436,255	6.50%
2012	57,520,001	1.90%
2013	58,036,948	0.90%
2014	59,566,132	2.60%
2015	61,032,022	2.50%
2016	60,786,937	0.40%
2017	64,500,386	6.10%
2011 – 2017 Passenger Growth		8,064,131
% Growth 2011 – 2017		15%

AIRPORT IMPACT RELIEF INCORPORATED EDR 2016 COMMENTS

12

The 2016 reports that in 2016, Logan added 4,708 more night operations (between 10 PM and 7 AM), with modeled average commercial jet operations rising from 89 in 1990, to 152 in 2016. These data indicate that there has been a 71% increase in commercial jet activity at Logan during the most noise sensitive period of the day, since 1990. Likewise, the data also show that 45% of the total increase since 1990 (29% overall) has occured over the previous 7 years, since 2010.

While the data indicate a rapid increase in nighttime noise impacts, EDR 2016 NEGLECTS to offer discussion and insight into the nature of the changes in nighttime airport uses, providing only retrospective analyses of the increases in nighttime operations.

Table 6-3 Modeled Nighttime Operations (10:00 PM to 7:00 AM) at Logan Airport Per Night[1]

	Commercial Jets	Commercial Non-Jets	General Aviation	Total
1990	77.2	11.7	N/A[2]	89.0
1998	101.4	21.9	20.9[3]	144.2
2000	103.9	21.6	5.7	131.2
2010	107.9	5.2	4.0	117.1
2011	109.4	4.7	6.7	120.8
2012	106.6	3.1	8.5	118.1
2013	115.9	3.2	6.3	125.4
2014	123.6	2.3	5.8	131.7
2015	131.0	2.4	5.8	139.1
2016	142.6	3.0	6.5	152.1
Change (2015 to 2016)	**11.6**	**0.6**	**0.7**	**12.9**
Percent Change	**8.9%**	**25.1%**	**12.4%**	**9.3%**

Source: Massport and Harris radar data; and HMMH, 2017.
Notes:
1 Data for all years beginning in 1990 are available in Appendix H, *Noise Abatement*.
2 Totals prior to 1998 do not include GA operations.
3 Previously reported as N/A. 1998 was the first year GA operations were reported and included in the total nighttime operations.

Combined with the 2016 EDR FAILURE to project future growth and noise impacts the 2016 EDR does not provide a comprehensive review of this major and growing impact source, nor create an adequate basis for public review of the airport's cumulative effects.

Specific Example Four: Operations Down, but Louder

EDR 2016 provides data that demonstrates that: operations are down since historic high levels were attained decades ago; that noise and pollution are less today than in the past, and; that newer, larger aircraft create less noise. These data might lead the reviewer to the assumption that impacts are down. But in fact, as passenger levels have risen in each of the past 5 years, noise and emissions have risen.

Additional information is needed to understand how impacts can be reported as down and yet be up, at the same time; how newer aircraft can be quieter and operations down, but noise rising, and annoyance through the roof.

Activity Levels

Boston-Logan International Airport 2016 EDR

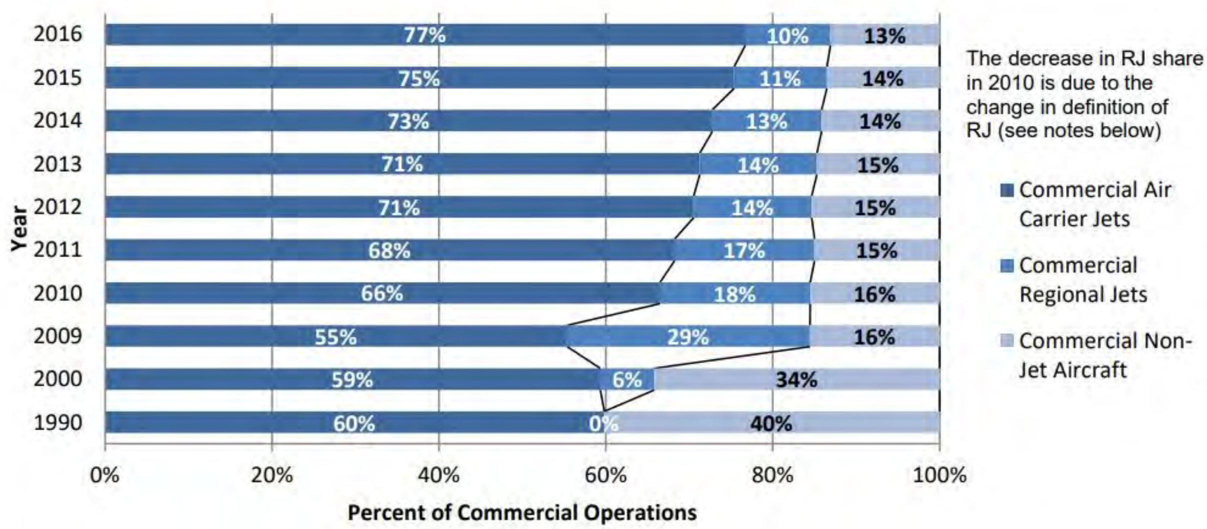
Table 2-2 Logan Airport Aircraft Operations (1990, 1998, 2000, and 2010 – 2016)

Category	1990	1998[1]	2000	2010	2011	2012	2013	2014	2015	2016	Percent Change (2015-2016)	Avg. Annual Growth (2010-2016)
Total Aircraft Operations	**424,568**	**507,449**	**487,996**	**352,643**	**368,987**	**354,869**	**361,339**	**363,797**	**372,930**	**391,222**	**4.9%**	**1.7%**
Operations by Type and Aircraft Class												
Passenger Jet	N/A	244,642	254,968	214,307	223,083	225,166	233,072	240,252	254,250	270,330	6.3%	3.9%
Passenger Regional Jet	N/A	12,172	37,600	66,498	61,704	46,753	47,875	44,079	38,229	36,564	(4.4%)	(9.5%)
Passenger Non-Jet	N/A	207,880	147,913	50,882	49,700	49,599	48,307	47,339	46,225	46,868	1.4%	(1.4%)
Total Passenger Operations	**N/A**	**464,694**	**440,481**	**331,687**	**334,487**	**321,518**	**329,254**	**331,670**	**338,705**	**353,762**	**4.4%**	**1.1%**
GA Jet Operations	N/A	13,636	20,595	11,430	21,129	21,042	21,237	21,025	20,589	24,499	9.3%	13.5%
GA Non-Jet Operations	N/A	18,076	14,638	3,252	7,101	7,072	5,445	5,391	7,577	6,281	9.3%	11.6%
Total GA Operations	**24,976**	**31,712**	**35,233**	**14,682**	**28,230**	**28,114**	**26,682**	**26,416**	**28,166**	**30,780**	**9.3%**	**13.1%**
Cargo Jet	N/A	10,428	11,788	5,332	5,053	4,220	4,647	4,911	5,605	5,745	10.2%	1.3%
Cargo Non-Jet	N/A	630	494	942	1,217	1,017	756	800	454	935	10.2%	(0.1%)
Total All-Cargo Operations	**N/A**	**11,058**	**12,282**	**6,274**	**6,270**	**5,237**	**5,403**	**5,711**	**6,059**	**6,680**	**10.2%**	**1.1%**

Source: Massport
Notes: Jet includes the Embraer E-190, which is a regional jet configured with 88 to 100 seats, but is similar in size to some traditional narrow-body jets.
Numbers in parentheses ( ) indicate negative numbers.
N/A Not Available.
1 1998 represents the historic peak in terms of aircraft operations for Logan Airport.

OMITTED is data explaining that the proportion of commercial jet vs, General Aviation operations has increased dramatically, from 55% in 1998, to 86% in 2016, meaning that 57,354 (20.5% more) additional commercial jets flew over metro Boston in 2018, than in 1998. This fact begins to explain the steady growth in noise impacted populations reported in the EDR and provides insight into future impacts as similar operational and passenger growth trends continue. Again here EDR 2016 FAILS to provide the needed discussion and analyses to produce comprehensible information upon which the average reader can form well-formed opinions.

Figure 6-1 Fleet Mix of Commercial Operations (Passenger and Cargo) at Logan Airport



Source: HMMH, 2017.

Notes: Includes both passenger and cargo operations.
After 2009, the split between air carrier jets and RJs is 90 seats with RJs having fewer than 90 seats.
Prior to 2010, the split between air carrier jets and RJs is 100 seats with RJs having fewer than 100 seats.

AIRPORT IMPACT RELIEF INCORPORATED EDR 2016 COMMENTS

15

Specific Example Five: Unreliable Planning Forecasts

EDR 2016 Executive Summary narrative information state Massport's expectation that Logan Airport will reach 40 million annual passengers by 2019 due to continued faster than expected passenger growth. The EDR also states that revised expectations for the local/national/international economy, and latest industry trends suggest that future Logan Airport passenger levels could reach about 46 million annual passengers. EDR 2016 does not specify a date by which this growth will be realized, but only promises that the ESPR 2017 will provide more forecasts out to 2030/2035.

PROJECTED PASSENGER VOLUME GROWTH AT 5% GROWTH RATE		
Passenger Volume	% Change	Total
2016		36.30
2017	1.06	38.48
2018	1.05	40.40
2019	1.05	42.42
2020	1.05	44.54
2021	1.05	46.77
2022	1.05	49.11
2023	1.05	51.56
2024	1.05	54.14
2025	1.05	56.85
2026	1.05	59.69
2027	1.05	62.68
2028	1.05	65.81
2029	1.05	69.10
2030	1.05	72.56
2031	1.05	76.18
2032	1.05	79.99
2033	1.05	83.99
2034	1.05	88.19
2035	1.05	92.60

Later in the EDR, Massport reports that 'passenger growth at Logan Airport has continued with increases of over 8 percent in 2016 and nearly 6 percent in 2017', suggesting that Logan will have processed over 39 million passengers by 2018.

Illustrating the failure of Massport's EDR environmental monitoring program further, ESPR 2011 forecasted growth up to 43 million by 2030. At current growth rates, this level should be surpassed by 2020, if not sooner. That EDR 2016 NEGLECTS to provide consistent and accurate information in an organized fashion regarding airport growth forecasts leaves reviewers of these MEPA environmental filings in the dark yet again about the scale of airport expansions being planned.

The consistent and unprecedented 4.8-percent annual average growth at Logan reported in the 2016 EDR places our already failing ground access transportation system, our fast-deteriorating air quality and ever-increasing noise levels at risk of unimaginable expansion. If left to continue unchecked, Logans passenger activity levels will fast be unmanageable. At 5% growth per year (roughly the 5 year average at Logan) Boston will host 72 million passengers in 2030, and over 92 million in 2035.

Forecast Airport Passengers - 2020 - Depressed, Base, and Enhanced Scenarios

Airport	Actual FY 2004	2020 Depressed	2020 Base	2020 Enhanced	Average Annual Growth Depressed	Average Annual Growth Base	Average Annual Growth Enhanced
BOS	24,477,000	38,302,000	42,437,000	49,578,000	2.8%	3.4%	4.4%
BDL	6,472,000	9,655,000	10,384,000	12,430,000	2.5%	2.9%	4.0%
PVD	5,253,000	8,551,000	9,057,000	11,195,000	3.0%	3.4%	4.7%
MHT	3,783,000	6,317,000	7,123,000	9,221,000	3.2%	3.9%	5.5%
PWM	1,265,000	2,089,000	2,347,000	2,781,000	3.1%	3.8%	4.9%
BTV	1,169,000	1,989,000	2,148,000	2,523,000	3.3%	3.8%	4.8%
BGR	445,000	776,000	833,000	971,000	3.4%	3.9%	4.8%
HVN	43,000	629,000	962,000	1,113,000	17.7%	20.7%	21.8%
ORH			284,000	536,000			
BED	26,000	37,000	451,000	790,000	2.2%	18.9%	23.0%
Total	42,933,000	68,345,000	76,026,000	91,138,000	2.9%	3.5%	4.7%

Specific Example Six: Competing, not Collaborating

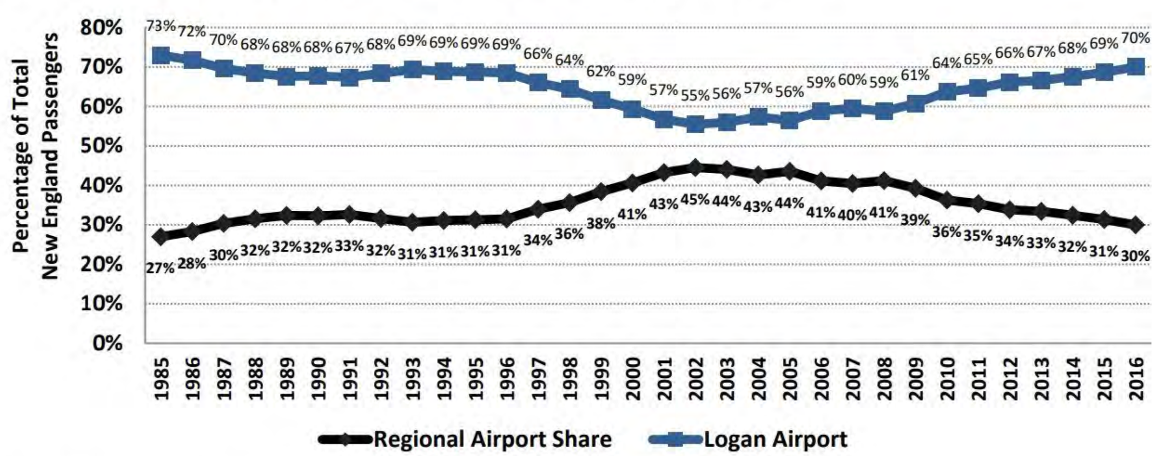
EDR 2016 states that 'Logan Airport is well-positioned in terms of access, competitive airfares, and available air services to meet the demands of the core Boston air passenger market. ...In 2016, the overall number of passengers accommodated at T.F. Green and Manchester-Boston Regional airports increased… by 2.4 percent… T.F. Green Airport and Manchester-Boston Regional Airport remain well situated to serve their own catchment areas. Here, Massport indicates that they plan to continue to segregate airport passenger demand management by 'catchment areas', when in fact, Logan's low-cost and direct travel options attract travelers from well beyond its catchment area. 28% of Logan's travelers come from beyond route 495.

With impacts in Boston so severe due to the city's higher population densities, bureaucratic territorialism should be put to an end, and the transportation needs of the Commonwealth should begin to be brought into focus in a logical approach to planning for the needs of the region in a strategic and justifiable manner. Use of regional airports to off-load increasing shares of the air travel market could

drive down impacts in Boston as when the Dukakis Administration Massport implemented policies designed to increase volumes at these airports, in the late 1990's.

Excess capacity in [New England Regional Airport System]() offers the best opportunity to relieve unwanted impacts of noise, emissions and traffic congestion around Logan and across metropolitan Boston. Governor Baker, EOEA, Massport's Board, and the Public should measure Massport's effectiveness not in terms of growth at Logan, but in terms of reduction in impacts and their success in spreading air travel activity to regional airports with excess capacity and lower environmental impact footprints than Logan.

Figure 4-3 Regional Airports' Share of New England Passengers, 1985-2016



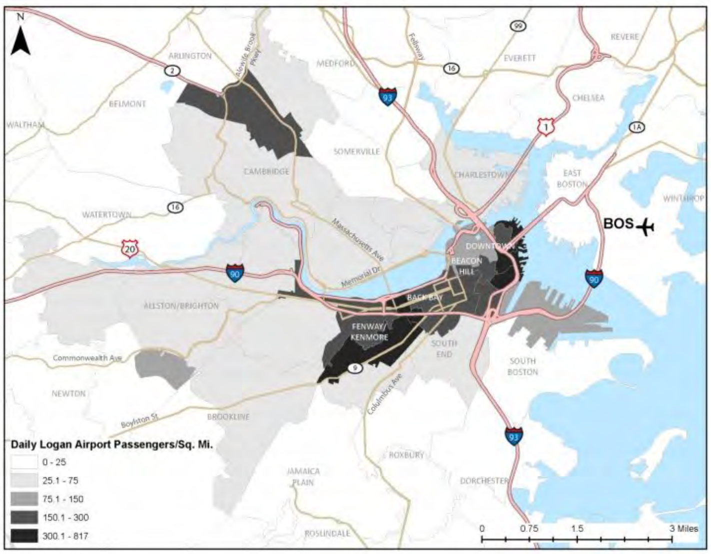
Source: Massport and individual airport data reports.

AIRPORT IMPACT RELIEF INCORPORATED EDR 2016 COMMENTS

18

Specific Example Seven: Poor Pricing Policies

FIGURE 6. DISTRIBUTION OF DAILY DEPARTING GROUND-ACCESS PASSENGER ORIGINS FROM URBAN CORE



EDR 2016 reports a 26% reduction in ridership of the Back Bay Logan Express Service. The EDR offers two possible rationales for declining Back Bay Logan Express (BBLE) ridership: the reopening of the Blue Line, and; the price increase for this service. However monthly ridership totals show a precipitous decline in BBLE ridership ONLY after a price hike, which went into effect in June.

OMITTED from the EDR analysis is information regarding the relationship of the timing of the reopening of the mass transit station, the price increase for the service, and the decline in ridership. Such information is vital to establishing the high level of sensitivity of air travelers to cost and convenience.

Table 5-9 Monthly Ridership on Back Bay Logan Express Service for 2015 and 2016

Month	2015	2016
January	16,742	18,440
February	14,671	17,120
March	24,930	24,527
April	23,175	22,078
May	27,638	30,369
June	25,655	16,720
July	28,118	17,087
August	28,746	15,208
September	27,311	14,784
October	25,848	14,368
November	25,126	14,945
December	22,838	10,683
Annual Total	**290,798**	**216,329**

The justification (as stated by Massport in the Globe article linked above) for raising the cost was to recoup more of the 2 million dollar cost of two years of this service. At a $1 million per year subsidy, the cost of this service was 3.50 per rider. Instead of raising the cost of this successful HOV service, million more riders should be found by expanding this successful HOV service. The cost of subsidizing such this expansion of HOV is a relative bargain. In fact, 2016 Ground Transportation Survey data provide strong evidence of significant ground access trip origin activity in Cambridge, the North End, Seaport, and Brookline, indicating that these areas could be fertile markets for expansion of this convenient and affordable downtown airport ground transportation service. If another million riders could be found, a 3% increase in HOV could be achieved.

Instead of seeking out, discussing and analyzing concrete opportunities to make real emissions reductions, Massport announces in the EDR 2016 its intention to seek paper reductions via introduction of 'a new definition for HOV that takes into account vehicle occupancies of taxi, livery (black car limousine), and transportation network company (TNC) modes.' This new definition is the result of an agreement between Massport and the Conservation Law Foundation (CLF) regarding the controversial 2017 Logan Airport Parking Freeze Amendment. Under the new system, Massport will count private passenger class vehicles with as few as two air travelers, as HOV in order to report improved HOV even while a higher percentage of passengers may be arriving via passenger car, taxi, Transportation Network Companies (TNC), and limousine modes, increasing pollution and congestion.

At the 40 million passenger level, which is likely to be eclipsed by 2018, Massport's paper gains could account for a 10% increase in reported HOV activity, while providing only the most minimal possible emissions benefits. This reclassification of HOV will disguise continued growth of high-pollution modes of ground access, which easily produce more than 5 times more emissions per traveler than bonafide HOV modes and contribute to the continued expansion of massive and uncontrolled environmental, economic and public health impacts of Logan airport, as beneficial transportation modes.

Continued EOEA facilitation of such policy-making will enable the next decade of regressive transportation and public health policy in the Commonwealth.

Specific Example Eight: Keeping Noise in the Dark

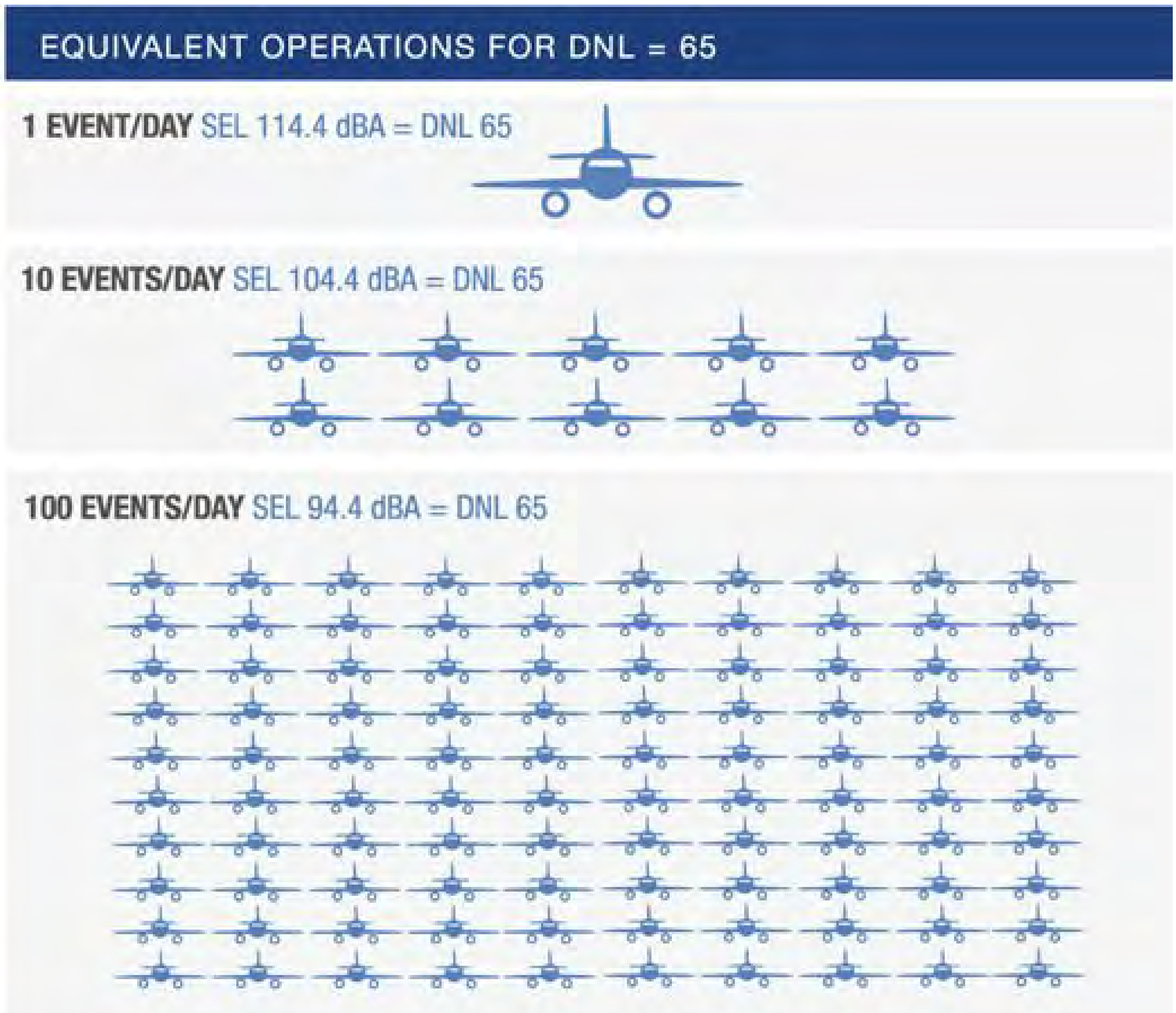
Table 6-7 Estimated Population within 65 dB[1] DNL Contour[2]

		Boston							
		East Boston	**South Boston**	**Total**	**Chelsea**	**Revere**	**Winthrop**	**Everett**	**Total**
1990	1980	NA	NA	30,748	4,813	4,274	4,307	0	44,142
2000	2000	8,979[3]	269	9,248[3]	0	2,496	6,001	0	17,745
2010 (INMv7.0b)	2010	689	0	689	0	2,413	728	0	3,830
2011 (INMv7.0c)	2010	331	0	331	0	2,574	1,069	0	3,947
2012 (INMv7.0c)	2010	439	0	439	0	2,772	1,525	0	4,736
2012 (INMv7.0d)	2010	421	0	421	0	2,762	1,386	0	4,569
2013 (INMv7.0d)	2010	612	0	612	0	2,505	1,190	0	4,307
2014 (INMv7.0d)	2010	4,185	0	4,185	0	2,832	1,905	0	8,922
2015 (INMv70.d)	2010	7,365	0	7,365	0	3,789	2,943	0	14,097
2015 (AEDT)[4]	2010	386	0	386	0	2,376	152	0	3,564
2016 (INMv7.0d)	2010	9,784	0	9,784	120	3,789	3,292	0	16,985
2016 (AEDT)	2010	4,031	0	4,031	0	2,376	1,043	0	7,450
Change from 2015 (INM) to 2016 (AEDT)		**(3,334)**	**0**	**(3,334)**	**0**	**(1,413)**	**(1,900)**	**0**	**(6,647)**
Change from 2015 (AEDT) to 2016 (AEDT)		**3,645**	**0**	**3,645**	**0**	**0**	**241**	**0**	**3,886**

Source: Massport and HMMH, 2017.
Notes: Population counts for 2000 are based on the 2000 U.S. Census block data and for 1990 from the 1980 U.S. Census block data. Population counts for 2010 through 2016 are provided for the 2010 U.S. Census block data (as indicated). Changes in ( ) represent a decrease in estimated population.
1 DNL 65 dB is the federally-defined noise criterion used as a guideline to identify where residential land use is considered incompatible with aircraft noise.
2 Data for years prior to 2010 are available in Appendix H, *Noise Abatement.*
3 These values reflect the effect of the FAA-approved terrain adjustment in Orient Heights.
4 Massport re-ran the *2015 EDR* contour in AEDT to use as a comparison in this table.

The extent to which the 2016 EDR FAILS to provide comprehension reaches new heights in the Noise Abatement Section. Beyond FAILING to provide any comprensible discussion about the history of and disadvantages of use of A-weighted sound measurements, or the ineffectiveness of use of average Day Night Levels, EDR 2016 FAILS to provide even the most basic explanation of the relative nature of sound energy events. Without fundamental comprehension of this confusing topic, technicality and jargonism leave the readers with virtually no chance of comprehending the reasons for increases in impacts over time. The 2016 Noise Abatement Section provides data without the context, or discussion of alternatives needed to understand and evaluate Logan's impacts, or to gather insights into future

changes in policies which might reduce impacts of this facility. As a case in point, EDR 2016 does not provide a comprehensive representation of the relationship between loud and louder events, *which is useful in understanding how noise energy can be less today than in the past, but annoyance and impacts can be much, much worse*.



This image, (found on the FAA website) explains how one extremely loud event can create the same noise impact as one hundred very loud events. Such graphics can provide readers with important insights into the measurements and allow them to compare the statistics used in the aviation industry. The EDR 2016, as all EDR and ESPR before it, frustrates and confuses using technical descriptions and evaluations which do not provide insights into the causes of noise impacts, or the potential solutions to their continued growth.

Specific Example Nine: Larger is Louder

EDR 2016 makes repeated reference to newer aircraft as 'larger and more efficient', and 'larger and quieter'. However, investigation of aircraft size to noise generation data provided by industry groups indicates that the newer, larger aircraft are louder too.

Effective Perceived Noise in Decibels	LEVEL	FLYOVER	APPROACH
A 318	92	82	94
A 321	95	86	96
A 340	96	94	98
A 380	95	93	97

OMITTED in the EDR discussion is the method by which the claims of noise reduction benefit are made relative to the newer aircraft. Without comprehensive discussion of the fact that this noise reduction claim is made relative to *per passenger noise generation*, the average reader would have no means of understanding that these 'quieter aircraft' actually produce more noise than their smaller counterparts. The above Table shows average EPNdB (Effective Perceived Noise Levels in decibels) for a selection of small, medium and large aircraft models produced by Airbus. It demonstrates that as aircraft get larger, the noise they produce in fact does not reduce, but instead it dramatically increases. The average increase in decibels between Airbus' smallest and largest aircraft is over 3 dB, reflecting a 100% increase in noise.

EDR failure to provide honest, and straightforward data and discussion are impeding the growth and effectiveness of the regional social negotiation around the noise issue. The evidence is clear that larger aircraft produce more noise.

Table 3: Departure Lmax levels by aircraft grouping

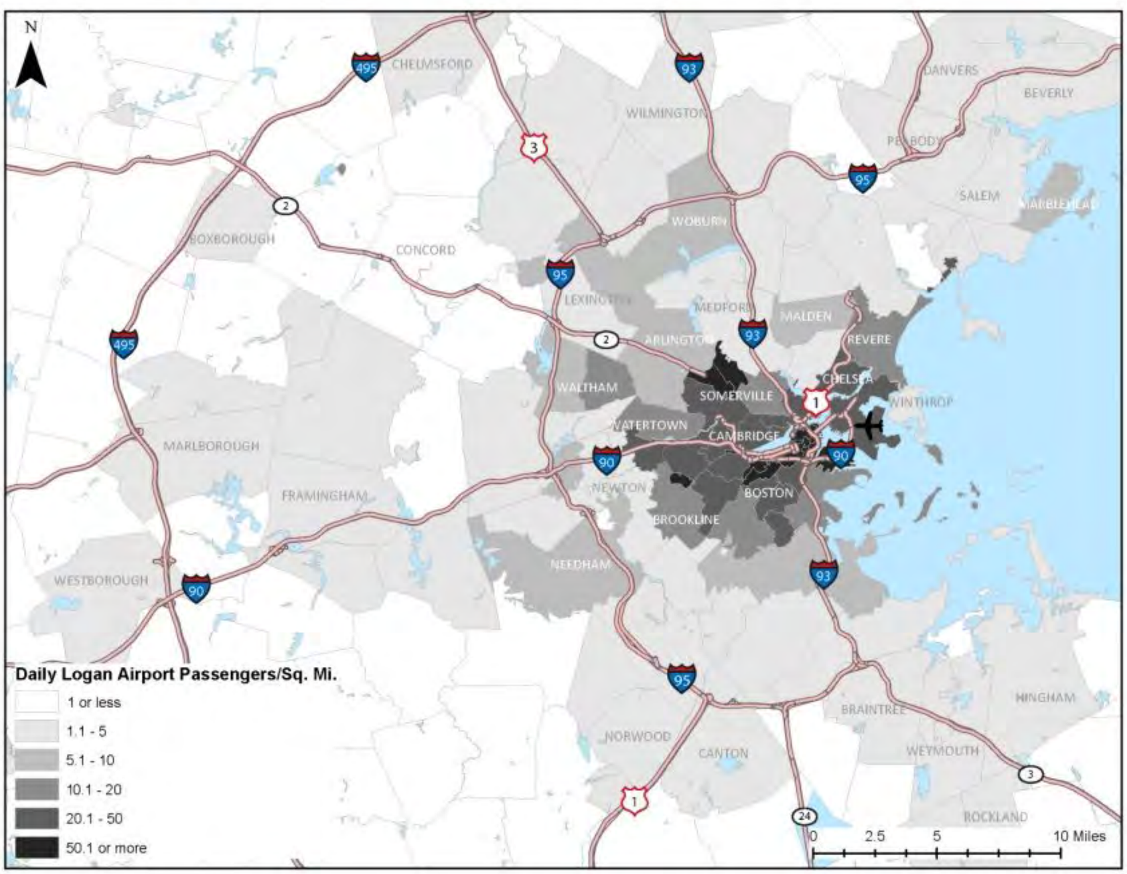
Height (ft)	Turbo-prop	50 seat regional jet	70-90 seat regional jet	125-180 seat single-aisle 2-eng jet	250 seat twin-aisle 2-eng jet	300-350 seat twin-aisle jet	400 seat 4-eng jet	500 seat 4-eng jet
1000-2000	78-71	78-70	85-75	85-75	92-83	90-81	92-84	91-84
2000-3000	71-67	70-65	75-68	75-70	83-77	81-75	84-79	84-80
3000-4000	67-64	65-60	68-64	70-66	77-73	75-71	79-75	80-76
4000-5000	64-62	60-57	64-61	66-63	73-69	71-67	75-72	76-73
5000-6000	62-60	57-55	61-58	63-60	69-66	67-64	72-69	73-71
6000-7000	60-58		58-56	60-59	66-64	64-62	69-67	71-68
7000-8000	58-56		56-56	59-58	64-61	62-60	67-64	68-66
8000-9000	56-56		56-55	58-57	61-59	60-58	64-62	66-65
9000-10000	56-55			57-56	59-58	58-57	62-60	65-63
10000-11000				56-56	58-57	57-56	60-60	63-62
11000-12000				56-56	57-56	56-55	60-59	62-60
12000-13000				56-55	56-56		59-58	60-59
13000-14000					56-55		58-58	59-58
14000-15000							58-57	58-55
15000-16000							57-57	
16000-17000							57-57	
17000-18000							57-56	
18000-19000							56-55	
19000-20000								

Specific Example Ten: Ignoring Success

2016 Ground Transportation Survey data show strong evidence of high levels of trip origination in the Beverley, Concord, and Norwood regions. If the success in Framingham could be duplicated across the system, further pricing and experience adjustments were researched and implemented, making the service even more desirable, and the system were expanded to include similarly successful service in these three additional regions, 2,113,439 an additional 297,770 riders could be expected. If additional improvements were made and prices were reduced, and additional 25% increase in ridership could be expected (this is roughly the reduction in ridership experienced with a price increase in the Back Bay Logan Express), raising the total ridership on the existing system by an additional 528,359 passengers, to 2,641,798. At an average of 660,449 annual passengers per terminal, the addition of three additional successful Logan Express terminals in Beverley, Concord, and Norwood would add an additional 1,981,348 HOV passengers, for a near-term adjusted total of one of the most desirable HOV modes, of 4,623,146 annual passengers.

Today's Logan Express is therefore likely being operated at 39% efficiency or lower. Lost, through the 2016 EDR's OMISSION of comprehensive reporting and analyses of HOV BRT ground transportation, is the opportunity to invest in healthy and equitable transportation solutions for the residents of the Commonwealth.

FIGURE 5. DISTRIBUTION OF DAILY DEPARTING GROUND-ACCESS PASSENGER ORIGINS



AIRPORT IMPACT RELIEF INCORPORATED EDR 2016 COMMENTS

24

It should be noted that adding 5,000 parking spaces at Logan will require an investment of hundreds of million dollars in one of the least desirable modes of ground transportation, yet, this same level of investment in Logan Express would easily provide for a 155% increase in this helpful and responsible mode of ground access to the airport.

Also OMITTED are data regarding the potential increases in Logan Express ridership which might be achieved at lower price points. EDR 2016 data indicate a $29 dollar fare for a single one-day airport round trip using Logan Express. Parking rates for the same trip would include $3.50 toll, plus a $32 first day parking fee for a total of $35.50 plus gas. Therefore there is only a $6.50 difference between driving and taking Logan Express. The EDR 2016 does not provide discussion or data on consumers preferences, market demand, or competitive positioning of these two competing options. However, as evidenced by the price sensitivity in Back Bay Logan Express ridership, and the user experience sensitivity evident in the Framingham Logan Express ridership increases following facility upgrades, price and experience are clear factors in mode choice decisions.

EDR 2016 fails to provide analyses of changes in market share which could be achieved at various price points for improved and more extensive HOV service to suburban locations which could increase HOV mode share by another 5%.

Effective Jet Aircraft Runway Use in Comparison to PRAS Goals

PRAS Effective Usage Goals		2014 Effective Usage		2015 Effective Usage		2016 Effecti
Arrivals	Departures	Arrivals	Departures	Arrivals	Departures	Arrivals
21.1%	5.6%	28.1%	4.9%	25.1%	4.1%	26.4%
0.0%	13.3%	0.0%	24.2%	0.0%	22.3%	0.0%
8.4%	23.3%	2.1%	11.6%	1.9%	13.1%	0.7%
6.5%	28.0%	30.4%	29.2%	31.3%	30.8%	**28.0%**
21.7%	17.9%	15.4%	15.0%	16.6%	14.6%	**20.4%**
42.3%	11.9%	23.4%	15.1%	24.5%	15.1%	24.0%
NA	NA	0.0%	<0.1%	0.0%	<0.1%	0.0%
NA	NA	0.6%	0.0%	0.5%	0.0%	0.6%

rt Noise Office and HMMH, 2017.
ɔals are stated in terms of effective jet operations which exclude non-jet flights, but which multiply each nigh
M to 7:00 AM) operation by a factor of 10.
‹t indicates runway use that is closer to PRAS goals from the prior year.
14-32 opened in late November 2006. (Runway 14-32 is unidirectional with no arrivals to Runway 14 and no
nway 32.) PRAS goals have not yet been established for Runways 14 and 32.

Specific Example Eleven: Abandoning Opportunity

EDR 2016 reports 'During Phase 2 of the recently concluded BLANS, the Logan Airport Community Advisory Committee (CAC) voted 'to abandon PRAS because it had not achieved the intended noise abatement'. However, EDR 2016 OMITS background information which is necessary to provide a comprehensive understanding of the context and legality of this vote. The BLANS objective RE PRAS was to update the runway use percentage goal planning in order to avoid a debated tripling of use of runway 15/33. The Logan CAC was never authorized to vote on abandonment of Logan's Runway Use Program. Thus, PRAS runway selection outputs are still reported.

Although EDR 2016 provided narrative insight into only the nighttime useage element of the PRAS Runway Use Program, PRAS definitions of effective runway use ALSO include placing limitations on the number of hours per day, or hours per 3 day period, that Air Traffic Controllers should use any single runway end. EDR 2016 also omits description of PRAS' method of prioritizing beneficial runway configuration selections to deal with constraints of wind speed and direction, weather conditions and other safety considerations. EDR 2016 oversimplification of this all-important airport topic, deprives the

residents of the Commonwealth of the opportunity to understand the essential FAILURES within the aviation industry's Air Traffic Control (ATC) system, which underlie PRAS' lack of success.

PRAS could have been successfully implemented, however ATC culture of laziness was not addressed by Massport. Boston Logan is a Tier One airport, meaning that its Air Traffic Controllers are paid more to deal with the increased complexity of Boston's converging runways, changing weather and heavy operational volumes. However, instead of using the recommendations of PRAS, which sometimes select lower capacity configurations to utilize less-often used runway ends when weather conditions allow, ATC simply often chose the highest capacity configurations to avoid the work of changing configurations in the event that demand should rise.

EDR 2016 fails to provide background discussion about the lack of compliance with PRAS, or provide any insights into the behavioral bases of thes Runway Use Plan's lack of implementation. EDR 2016 NEGLECTS to explain that PRAS is an INFORMAL RUP, meaning that it is not mandatory that Air Traffic Controllers use its recommendations. In order for readers to gain insights into the FAA, Airport and Airline culture in the US, to help them comprehend the behaviors and decisions which are attuned to business and growth initiatives, but insensitive to community impacts, the EDR would need to include careful discussion of air travel industry military-style, technical and bureaucratic culture.

This Page Intentionally Left Blank.

Comment #	Author	Topic	Comment	Response
6-1	Gail Miller, President, Airport Impact Relief, Inc.	Activity Levels / Environmental Impacts	We are requesting that EOEA / DEP acknowledge the correlations, found in multiple studies and in particular in the research file labeled 'Hudda Chelsea 2018' in the folder linked above, between the reported airport passenger and commercial operational year to year growth between 2011 and 2016 and increases in noise, traffic congestion and emissions as reported in the 2016 EDR; and that EOEA / DEP provide in the Certification notice for EEA 3247, EOEA's disposition regarding regulation, measurement and reduction activities of current and anticipated levels given the Massachusetts Port Authority's present uncontrolled growth and the agency's plans and projections of continued growth in operations into the future.	In the past few years, passenger demand trends for air travel have been rapidly increasing and the air carrier landscape has changed significantly. Additionally, the ground transportation arena at Logan Airport has also changed rapidly with the introduction of transportation network companies (TNCs) such as Uber and Lyft. The results of current trends, future forecasts, and ground transportation data is reported in this *2017 Environmental Status and Planning Report (ESPR).* See Chapter 2, *Activity Levels* , and Chapter 5, *Ground Access to and From Logan Airport.* In the submission of Environmental Data Reports (EDRs) and ESPRs Massport presents a comparison of current and historical information on air quality in Chapter 7, *Air Quality/Emissions Reduction,* noise in Chapter 6, *Noise Abatement,* and traffic in Chapter 5, *Ground Access to and from Logan Airport.* As part of the Massachusetts Environmental Policy Act (MEPA) Environmental Impact Report (EIR) Certificate for the Logan Airside Improvements Project, a two-year air quality monitoring study was undertaken in the communities near the airport - including those located near the take-off and landing areas. The data included particulate matter ($PM_{2.5}$) and Black Carbon particles and an assortment of volatile organic compounds (e.g., formaldehyde, naphthalene, etc.). Although partly inclusive of the particles, the smallest (e.g., ultrafine particles [UFP]) were not specifically measured. Another study conducted by the Massachusetts Department of Public Health (MassDPH), evaluated human health effects in communities located near the Airport. Among the findings was an elevated increase in the incidence of respiratory effects when compared to low exposure areas. However, the study also concluded that this outcome cannot be attributable to the Airport alone when combined with emissions from motor vehicle traffic, industrial facilities, etc. Logan Airport is a case study of a research effort undertaken by the Federal Aviation Administration (FAA) Center of Excellence for Alternative Jet Fuels and Environment, Aviation Sustainability Center (ASCENT). The research project measured and modeled UFPs for one runway end at Logan Airport in July 2017 and separated contribution of aircraft sources from other sources. The study will include additional work to include both arrival and departure flight paths. Massport will report on the findings of the study in the next EDR, if available.
6-2	Gail Miller, President, Airport Impact Relief, Inc.	Community Engagement	We call on EOEA to break the cycle of failure in environmental planning at Massport by taking action to improve community engagement in the EDR writing and release process. We are requesting that DEP and EOEA engage AIR, Inc., GreenRoots, Conservation Law Foundation (CLF), Action for Community and Environment (ACE) directly, starting immediately in development of a Rolling Environmental Review which would build opportunity for partnership between environmental justice communities in Boston, the Port Authority, and DEP in the improvement of the MEPA environmental review process as it relates to airport planning. Such collaboration would create vast improvements in delivery of environmental justice, as well as in the quality and effectiveness of airport environmental reports and plans.	Massport engages directly with the neighboring communities on environmental issues through the Massport Community Advisory Committee (CAC). Massport welcomes public comments on EDRs and ESPRs, along with other published documents. Communities around Massport can submit public comment or noise complaints through the Massport and Massport CAC websites: http://www.massport.com/massport/about-massport/contact/ and http://massportcac.org/noise/
6-3	Gail Miller, President, Airport Impact Relief, Inc.	Noise	We ask that the Secretary acknowledged in the his Certification Documentation the lack of comprehensive review and discussion of the existence of the practice of restricting nighttime operations which is used in Europe, and the failure of the EDR to present information regarding the potential benefits of similar nighttime flight restriction policies at Logan.	Nighttime restrictions such as those implemented at airports in Europe are not permitted in the United States. The current Logan Airport restrictions were enacted prior to the Airport Noise and Capacity Act (ANCA) and are grandfathered in at Logan Airport. Any new access restrictions to Logan Airport, is prohibited by current federal laws. For further information see the Part 161 discussion in Appendix H, *Noise Abatement.* Massport will continue to work with local communities, through the Massport CAC. The appropriate forum for further noise issues and discussions continues to be through the Massport CAC.

Comment #	Author	Topic	Comment	Response
6-4	Gail Miller, President, Airport Impact Relief, Inc.	Economic Impacts	Further analysis is needed to understand the airport's impact on rents and real estate sales prices across the broader region, but regional economic losses throughout East Boston, Winthrop, Chelsea, Revere, and now increasingly in suburban communities such as Milton, Medford and Malden are significant and would easily reach into the 100's of millions in lost rental income and reduced sales prices.	Information on the economic impact of Logan Airport and the other state airport facilities can be found at https://www.mass.gov/files/documents/2019/03/25/AeroEcon_ImpactStudy_January2019.pdf. The report states that Logan Airport generated over 162,000 jobs, and a total payroll of almost $6 billion.
6-5	Gail Miller, President, Airport Impact Relief, Inc.	Economic Impacts	We ask that the Secretary acknowledge, in his Certificate for EEA 3247, the lack of comprehensive data provided on the range of economic costs of airport operations in EDR 2016, and; that Massport be required to provide supplemental data on these important costs of the cumulative impacts of Boston Logan airport as an addendum to EDR 2016. Such analyses should be required in all upcoming EDR and ESPR.	The EDRs and ESPRs are intended to provide a cumulative snapshot of economic and environmental conditions. Massport considers the economic impact of the Airport on the region and community in this *2017 ESPR* (see Chapter 2, *Activity Levels*) and in its Annual Report. The 2018 Comprehensive Annual Financial Report provides information regarding costs, revenue, demographic data, number of employees and jobs. See http://www.massport.com/media/3029/mpa-fy18-cafr-final.pdf. Information on the economic impact of Logan Airport and the other state airport facilities can be found at https://www.mass.gov/files/documents/2019/03/25/AeroEcon_ImpactStudy_January2019.pdf. The report states that Logan Airport generated over 162,000 jobs, and a total payroll of almost $6 billion.
6-6	Gail Miller, President, Airport Impact Relief, Inc.	Air Quality	We ask that the Secretary require Massport, as a condition of his Certification document, to produce supplemental review and analyses of ongoing air quality measurement practices, techniques and innovations including specifically, the ARISense collaboration, and that the Port Authority be required under the same condition to engage with AIR, Inc. and its partners, assess the System's capabilities, provide a brief report on such capabilities, and include in this report the agency's disposition toward joining in this Partnership.	Massport staff have coordinated with the ongoing AIRSense Study. Massport supports ongoing research and collaborates with local scientists by providing data (e.g., aircraft operations, methodologic data, etc.). Massport will support and closely follow the findings of research studies required under the FAA Reauthorization Act of 2018. Specific studies of interest include evaluation of an alternative airplane noise metric; assessment of lead in aviation gasoline and mitigation to reduce ambient lead concentrations; analysis of the relationship between jet aircraft approach and takeoff speeds and corresponding noise impacts on surrounding communities; review of the relationship between aircraft noise exposure and its effects on communities around airports; and the study of potential health and economic impacts of overflight noise (which includes Boston as a case study). See https://www.congress.gov/bill/115th-congress/house-bill/4/text for additional information. Massport is supportive of and is following a research effort undertaken by the FAA Center of Excellence for Alternative Jet Fuels and Environment, Aviation Sustainability Center (ASCENT) attempting to measure UFP emissions related to aircraft and other sources. In July 2017, the research project measured and modeled UFPs for one runway end at Logan Airport. The study is ongoing and will reflect both arrival and departure flight paths. Massport will report on the findings of the study in the next EDR, if available.

Comment #	Author	Topic	Comment	Response
6-7	Gail Miller, President, Airport Impact Relief, Inc.	Ground Access / Air Quality	The EDR 2016 Certificate should include conditions that require: Analysis and reporting of changes in HOV mode share, parking demand, tunnel traffic, and air pollution which could be attained through expanded and improved Logan Express service.	In accordance with the Secretary's Certificate, Massport developed a new definition of high-occupancy vehicle (HOV) modes, updating the definition to include the increased knowledge and data from the rapidly changing transportation landscape due to the emergence of transportation network companies (TNCs), such as Uber and Lyft, and the impacts on the ground access network. With this ESPR, Massport defines HOVs as, taxis, black car limousines, and TNCs that carry two or more air passengers per vehicle as HOV. Additional information is provided in Chapter 5, *Ground Access to and from Logan Airport*. With this updated definition, Massport has committed to a goal of 35.5 percent HOV by 2022 and 40 percent by 2027. Given the recent increase of TNCs travel modes to and from Logan Airport, Massport has a goal to double Logan Express ridership from 2 million to 4 million passengers, thereby reducing vehicle miles traveled (VMT), congestion, and air quality emissions. Massport continues to provide and actively promote numerous HOV and shared ride options to air passengers, including Logan Express bus service, the MBTA Silver Line, water shuttle services, and frequent, free shuttle bus service to and from the MBTA Blue Line Airport Station. Massport is investigating ways to increase HOV mode share by implementing new HOV initiatives and pricing strategies. This includes improving Back Bay Logan Express service, starting a new Urban Express service at North Station, investing in existing suburban Logan Express sites, investing in structured parking at Logan Express sites, and evaluating new suburban Logan Express locations. Details about these initiatives can be found in Chapter 5, *Ground Access To and From Logan Airport.* Logan Airport continues to rank at the top of U.S. airports in terms of HOV/transit mode share.
6-8	Gail Miller, President, Airport Impact Relief, Inc.	Ground Access	The EDR 2016 Certificate should include conditions that require: The EDR 2016 Certificate should include conditions that require: Massport should be required to model and or otherwise research the market share effect of adding a minimum of 5 additional [Logan Express] locations with regular service (every 20 minutes) throughout metro-Boston region, creating a network of fast, convenient, clean and affordable HOV airport access at mass transit price points.	Logan Express ridership has steadily increased since 2010, equaling 1,835,736 passengers in 2017. Across the five Logan Express service locations there are variable results, many of these changes can be attributed to changes in other modes of public or HOV-transit. Most notably, the decrease in passenger activity of the Back Bay Logan Express which decreased about 37 percent since 2016. This reduction in ridership can be attributed to the re-opening of the Government Center Station in March 2016. The Back Bay Logan Express Station is part of a pilot project that started in 2014. Massport is continuing to find efficient ways to provide a broad range of HOV, transit, and shared-ride options for travel to and from Logan Airport and to minimize vehicle trips. Massport has a goal to double Logan Express ridership from 2 million to 4 million annual riders. These strategies include exploring sites for a new suburban location, expanded schedules, and additional amenities for riders. As outlined in the *2017 ESPR,* Massport proposes to implement a new urban Logan Express Station at North Station and plans to pursue a new suburban Logan Express station. The North Station service is anticipated to begin in 2020 and will offer service to Logan Airport for $3.00, service is planned to begin in 2020. Additionally, eight Silver Line buses will be purchased to allow for increased frequencies. For more information, see Chapter 5, *Ground Access to and from Logan Airport.*
6-9	Gail Miller, President, Airport Impact Relief, Inc.	Ground Access	The EDR 2016 Certificate should include conditions that require: Massport should be required to model and research the benefit of improving service by implementing best practices in Bus Rapid Transit (BRT) such as offering free WIFI and electronic ticketing while also maintaining prices of all express airport bus service expansions at the $5, (free with a valid MBTA pass) levels established prior to the implementation of increased pricing.	Massport is continually developing strategies to improve HOV-transit to and from Logan Airport. Massport introduced free boarding's of the MBTA Silver Line at Logan Airport, eliminating the need for fareboxes. The Logan Express system offers service from five different locations across the Greater Boston Area and experienced steady growth since 2010, equaling 1,835,736 passengers in 2017. Massport has a goal to double Logan Express ridership from 2 million to 4 million annual riders. These strategies include exploring sites for new urban and suburban locations, expanded schedules, and additional amenities for riders (e.g., WIFI). Massport currently offers WIFI on the Woburn Logan Express. Massport plans to add up to 1,000 additional spaces to the parking garage at the Framingham site and is considering building up to 3,000 structured parking spaces at the Braintree site. Massport increased the Braintree Logan Express service from two to three trips per hour. For more information, see Chapter 5, *Ground Access to and from Logan Airport.*

Comment #	Author	Topic	Comment	Response
6-10	Gail Miller, President, Airport Impact Relief, Inc.	Ground Access	The EDR 2016 Certificate should include conditions that require: Analysis and reporting of changes in HOV mode share, parking demand, tunnel traffic, and air pollution associated with a variety of pricing disincentives for passenger car airport ground access modes via increasing on-airport parking rates at Logan to position all forms of short-term airport parking (including in-garage, cell phone lot and curbside options) at higher price points than MBTA and Logan Express options	Measures implemented by Massport include a blend of strategies related to pricing (incentives and disincentives), service availability, service quality, marketing, and traveler information. Due to the wide-demographics of Logan Airport air passenger travelers, no single measure can accomplish the HOV mode share goal. Massport increased on-Airport parking rates in 2017 and maintained the lower Logan Express daily parking rates. It is likely that these policies contributed to the 6.2-percent growth of the Logan Express suburban park-and-ride program. Massport plans to add up to 1,000 additional spaces to the parking garage at the Framingham site and is considering building up to 3,000 structured parking spaces at the Braintree site. Additionally, Massport is proposing to add 2,000 new commercial spaces in a new garage in front of Terminal E and 3,000 additional spaces through an expansion to the Economy Garage. While short-term parking has been trending down since 2010, all other parking durations have remained relatively constant. In 2017, there was a flat growth (less than 1 percent) in overall parking coupled with a decrease in short-term parking (1.3 percent), and an increase in the number of total vehicles entering the Airport. The Cell Phone Waiting Lot in the vicinity of Terminal E, which is free of charge, offers 61 parking spaces where drivers can wait for arriving passengers. The Cell Phone Waiting Lot reduces vehicle emissions by minimizing idling and reducing VMT on-Airport by motorists. More information about Massport's initiatives can be found in Chapter 5, *Ground Access to and From Logan Airport*.
6-11	Gail Miller, President, Airport Impact Relief, Inc.	Ground Access	The EDR 2016 Certificate should include conditions that require: Analysis and reporting of changes in HOV mode share, parking demand, tunnel traffic, and air pollution associated with reducing suburban Logan Express Service price points to attract a greater share of drop-off and pick up mode travelers. This initiative would work in conjunction with increases in the cost structure of on-airport short term parking options.	Massport has maintained a $22 round trip adult fare, with a free fare to seniors and children under the age of 17, at its suburban Logan Express locations, to promote ridership. There was a 6.2-percent growth of the Logan Express suburban park-and-ride program from 2016 to 2017, and ridership growth continued in 2018. Massport has a goal to double Logan Express ridership to 4 million passengers to reduce VMT, congestion, and air quality emissions. This includes improving Back Bay Logan Express service with discounted rates and a change in location, starting a new urban express service at North Station, increasing Braintree Logan Express service to three trips per hour, adding up to 1,000 additional spaces to the parking garage at the Framingham site, and considering building up to 3,000 structured parking spaces at the Braintree site. More information about Massport's initiatives can be found in Chapter 5, *Ground Access To and From Logan Airport*.
6-12	Gail Miller, President, Airport Impact Relief, Inc.	Ground Access	The EDR 2016 Certificate should include conditions that require: Analysis and reporting of changes in mass transit mode share increases, parking capacity, tunnel traffic, and air pollution attainable through corrections to the pricing of on-airport parking and Logan Express options, through improvement of the MBTA system, specifically through development of a direct connection between the Red and Blue Lines, and extension of the Blue Line to Lynn.	Massport is continuing to model efficient ways to provide a broad range of HOV, transit, and shared-ride options for travel to and from Logan Airport and to minimize vehicle trips. Massport has a goal to double Logan Express ridership from 2 million to 4 million annual riders. Additionally, Massport is committed to increasing its HOV mode share to 40 percent by 2027. While the MBTA transit system is not under Massport's jurisdiction, these initiatives will support efforts in reducing vehicles through these roadways.
6-13	Gail Miller, President, Airport Impact Relief, Inc.	Environmental Impacts	Set caps on pollution, noise, and traffic at current levels. Massport has proven incapable of slowing expansion of these public-health-damaging impacts.	The *2017 ESPR* is intended to provide a cumulative snapshot of environmental conditions and provides current and historical information on air quality in Chapter 7, *Air Quality/Emissions Reduction,* noise in Chapter 6, *Noise Abatement,* and traffic in Chapter 5, G*round Access to and from Logan Airport.* Following federal deregulation of airlines in the 1970s, airlines were authorized to set their own routes, service frequency, and type of aircraft. Massport does not have the authority to limit or otherwise cap the number of flights at an airport; only the Federal Aviation Administration (FAA) has this authority. Massport advocates for the use of newer, more efficient technology at Logan Airport. For example, almost 98 percent of the 2017 commercial jet operations met the strictest noise limits (Stage IV and V). See Table 6-3 in Chapter 6, *Noise Abatement* of the ESPR for percentage of commercial jet operations by Part 36 stage category. Massport is continually looking for ways to decrease pollution and improve traffic conditions at Logan Airport. Initiatives to increase the efficiency of buildings and accessibility of public transit to Logan Airport for passengers and employees are reported on in the *2017 ESPR*.

Comment #	Author	Topic	Comment	Response
6-14	Gail Miller, President, Airport Impact Relief, Inc.	Environmental Impacts/ Community Engagement	Require Massport to create specific year to year impact reduction target goals and to provide specific plans, supported by appropriate modeling and a robust public comment process developed specifically to engage the public (including in Environmental Justice Communities) in these plans.	The intent of the ESPR is to provide a review of airport activity and environmental conditions for the reporting year compared to previous years and future conditions. Chapter 5, *Ground Access to and from Logan Airport,* Chapter 6, *Noise Abatement,* and Chapter 7, *Air Quality/Emissions Reduction* each include management plans that report on Massport's environmental goals and progress towards meeting those goals. In addition, Massport undertakes several initiatives that are reported in EDRs and ESPRs such as the Logan Airport Sustainability Management Plan and Massport's Environmental Management System. Massport continually looks for ways to increase knowledge sharing and public outreach to the neighboring communities, both online and in-person. Massport also engages with the Massport CAC on an ongoing basis on a variety of topics.
6-15	Gail Miller, President, Airport Impact Relief, Inc.	Environmental Impacts	Establish an enforcement plan to incentivize Massport to achieve their impact reduction targets	The ESPR provides information on environmental conditions and regulatory requirements. The technical chapters outline management plans that describe Massport's goals for reducing airport impacts and progress towards meeting those goals.
6-16	Gail Miller, President, Airport Impact Relief, Inc.	Environmental Impacts	Require Massport to provide reporting and analyses on increases in traffic, noise and pollution relative to recent historic low impact levels to focus public and agency attention on the important need to reverse the alarming trends in the growth of negative impacts, in understanding trends in airport pollution, and to assist the public in assessing current policies' capacity to create the needed public health gains.	The *2017 ESPR* provides current and historical information on air quality in Chapter 7, *Air Quality/Emissions Reduction,* noise in Chapter 6, *Noise Abatement,* and traffic in Chapter 5, *Ground Access to and from Logan Airport.* Massport analyzes and reports on environmental conditions and trends, and outlines plans to increase the efficiency of the Airport to lessen adverse environmental impacts. Massport provides an update on the status and findings of the Massachusetts Department of Public Health (MassDPH) Logan Airport Health Study and Massport's air quality studies in the annual EDRs and ESPRs. The latest update on the health study is provided in Chapter 7, *Air Quality/Emissions Reduction.* The results of the health studies are also available online at: http://www.mass.gov/eohhs/docs/dph/environmental/investigations/logan/logan-airport-health-study-final.pdf.
6-17	Gail Miller, President, Airport Impact Relief, Inc.	Ground Access	The Secretary should require Massport to produce specific and credible plans to reduce passenger car modes of transportation through the harbor tunnels and improvement of mass transit travel modes to Logan.	The *2017 ESPR* provides updates to HOV, transit, and shared-ride initiatives to reduce vehicle trips to and from Logan Airport and improve mass transit travel modes to and from Logan Airport. The ground transportation arena at Logan Airport has also changed rapidly with the introduction of TNCs, such as Uber and Lyft. The additional time granted by the Notice of Project Change, signed by the Secretary, afforded Massport the time necessary to gain a clearer understanding of the future forecast and ground transportation data. The results of the future forecasts and ground transportation data are reported in the *2017 ESPR.* With this ESPR, Massport defines HOVs as, taxis, black car limousines, and TNCs that carry two or more air passengers per vehicle as HOV. Additional information is provided in Chapter 5, *Ground Access to and from Logan Airport.* With this updated definition, Massport has committed to a goal of 35.5 percent HOV by 2022 and 40 percent by 2027. Given the recent increase of TNC travel modes to and from Logan Airport, Massport has a goal to double Logan Express ridership from 2 million to 4 million passengers, thereby reducing VMT, congestion, and air quality emissions. Massport continues to provide and actively promote numerous HOV and shared ride options to air passengers, including Logan Express bus service, the MBTA Silver Line, water shuttle services, and frequent, free shuttle bus service to and from the MBTA Blue Line Airport Station. Massport is investigating ways to increase HOV mode share by implementing new HOV initiatives and pricing strategies. This includes improving Back Bay Logan Express service, starting a new Urban Express service at North Station, investing in existing suburban Logan Express sites, investing in structured parking at Logan Express sites, and evaluating new suburban Logan Express locations. Details about these initiatives can be found in Chapter 5, *Ground Access To and From Logan Airport.* Logan Airport continues to rank one of the top of U.S. airports in terms of HOV/transit mode share.
6-18	Gail Miller, President, Airport Impact Relief, Inc.	Noise	To hold Massport accountable for Logan's noise impacts, this agency should be required to develop noise level modeling which reflects alternative operational levels inclusive of attainable shifts of flight operations to other viable New England airports, specifically including target off-loading goals to TF Green and Manchester Boston.	The *2017 ESPR* provides an update on the status of regional airports and ongoing initiatives. Massport continues to invest in Worcester Regional Airport and has initiated a $100-million, 10-year investment to revitalize and attract commercial operations to Worcester Regional Airport. More details can be found in Chapter 4, *Regional Transportation.*

Comment #	Author	Topic	Comment	Response
6-19	Gail Miller, President, Airport Impact Relief, Inc.	Noise	The Secretary should require Massport to model noise impacts at reduced operational levels in low, mid and high target reduction goal scenarios which could be achieved through aggressive diversion of flights to other New England airports, as well as reductions attainable through a night time noise curfew.	The *2017 ESPR* provides an update on the status of regional airports and ongoing initiatives. Massport continues to invest in Worcester Regional Airport and has initiated a $100-million, 10-year investment to revitalize and attract commercial operations to Worcester Regional Airport. More details can be found in Chapter 4, *Regional Transportation.* Massport used the FAA required AEDT model for its noise assessment and follows federal guidelines for analyzing noise at Logan Airport.
6-20	Gail Miller, President, Airport Impact Relief, Inc.	Environmental Impacts	EOEA's response to this EDR must set forward regulatory structure that will advance long-overdue transportation policy reforms, reverse negative health and quality of life trends in our communities (reported in the EDR), and correct Massport's organizational disregard for the health and safety of stakeholders on the ground.	The *2017 ESPR* provides current and historical information on air quality in Chapter 7, *Air Quality/Emissions Reduction,* noise in Chapter 6, *Noise Abatement,* and traffic in Chapter 5, *Ground Access to and from Logan Airport.* Massport analyzes and reports on environmental conditions and trends, and outlines plans to increase the efficiency of the Airport to lessen adverse environmental impacts. Massport provides an update on the status and findings of the MassDPH Logan Airport Health Study and Massport's air quality studies in the annual EDRs and ESPRs. The latest update on the health study is provided in Chapter 7, *Air Quality/Emissions Reduction.* The results of the health studies are also available online at: http://www.mass.gov/eohhs/docs/dph/environmental/investigations/logan/logan-airport-health-study-final.pdf.
6-21	Gail Miller, President, Airport Impact Relief, Inc.	Content / Community Engagement	EOEA should require the Port Authority to convene a subset of community stakeholders including AIR, Inc., GreenRoots, Fair Skies Nation, Conservation Law Foundation, the Massport CAC, and other community stakeholder groups mutually agreed upon via majority vote of this subset of groups, as a 2016 Supplemental Environmental Reporting Task Force, in the development of a Supplemental EDR 2016 which will include accurate and easy to read representation of the level and causes of airport impacts; the range of policy alternatives, a comprehensive cataloguing of airport economic costs, and an assessment of available responses to slow the growth of emissions, traffic and noise.	Massport has worked with the Executive Office of Energy and Environmental Affairs (EEA) to have public input into the EDR and ESPR through public meetings and comments. Massport engages directly with the neighboring communities on environmental issues through the Massport CAC. Massport continually looks for ways to increase knowledge sharing and public outreach to the neighboring communities and community stakeholders, both online and in-person. Massport is constantly working to refine EDRs and ESPRs to create comprehensive reports that are both readable and succinct but are technically sound. Massport understands the technical nature and complexity in the reporting of some environmental analyses and impacts, but where applicable infographics and charts are used to aid in the display of technical information or data. Massport provides datasets for technical chapters in the appendices of the *2017 ESPR* to improve readability and minimize chapter length.
6-22	Gail Miller, President, Airport Impact Relief, Inc.	Content / Environmental Justice	To improve Massport compliance with EJ reporting standards, we request that EOEA require Massport conduct a thorough review of available EJ best practices guidance (example: https://www.fws.gov/environmental-justice/pdfs/nepa_promising_practices_document_2016.pdf)	Massport is mindful of its neighbors and has prepared Chapter 1, *Introduction/Executive Summary* of the EDRs, and now the ESPRs, in Spanish, to provide information to the community. Recently completed Spanish language documents can be found on Massport's website at http://www.massport.com/massport/about-massport/project-environmental-filings/logan-airport/. Notices of availability and public meetings are provided in Spanish, and Spanish translators are available at public meetings.

Comment #	Author	Topic	Comment	Response
6-23	Gail Miller, President, Airport Impact Relief, Inc.	Content / Environmental Justice/ Community Engagement	To improve Massport compliance with EJ reporting standards, we request that EOEA require Massport engage with EJ community groups (specifically including AIR, Inc., GreenRoots, and other groups mutually agreed-upon by these two local leadership EJ organizations) in creating a Supplemental Executive Summary which will incorporate best practices in EJ communications and result in an effective and productive dialogue regarding this document, the data it presents, and the policy choices it explains, with the intent to provide comprehensive educational benefit in EJ communities and beyond.	This *2017 ESPR* includes a Spanish translation of Chapter 1, *Introduction/Executive Summary.* Notices of availability and public meetings are provided in Spanish, and Spanish translators are available at public meetings. Massport continually looks for ways to increase knowledge sharing and public outreach to the neighboring communities (including environmental justice [EJ] communities), both online and in-person. Massport engages directly with the surrounding communities on issues through the Massport CAC, which includes representatives from EJ communities. Massport provides datasets for technical chapters in the appendices of the *2017 ESPR.* Additionally, Massport welcomes any comments about these reports during its public meetings or in writing.
6-24	Gail Miller, President, Airport Impact Relief, Inc.	Additional Data	Additional information is needed to understand how impacts can be reported as down and yet be up, at the same time; how newer aircraft can be quieter and operations down, but noise rising, and annoyance through the roof.	Over the longterm, noise levels of aircraft have decreased due to quieter engines and airline efficiency. However, with recent ongoing economic growth, overall annual operations in 2017 increased by 2.6 percent compared to 2016, increasing from 391,222 operations in 2016 to 401,371 operations in 2017, which translates to about 1,069 operations per day in 2016 and 1,100 operations per day in 2017. Almost 98 percent of the 2017 commercial jet fleet at Logan Airport meets at least Stage 4 requirements and about 18 percent of Logan Airport's commercial jet fleet complies with the FAA's newest noise category, Stage 5. Chapter 6, *Noise Abatement* provides information on aircraft operations, aircraft fleet mix, and noise levels. The overall shape of the 2017 contours is very similar to 2016 conditions, with any differences attributable to the types of aircraft operations that occurred in a given area and the proportion of nighttime operations. However, the 2017 contour has expanded in extent reflecting the 2.6-percent increase in operations from 2016 to 2017. The total number of people counted from 2010 U.S. Census data as residing within the DNL 65 dB contour increased from 7,450 in 2016 to 7,933 in 2017 (a total of 483 people), with most of the increases in East Boston and Revere.

This Page Intentionally Left Blank.

GreenRoots

July 31, 2018

The Honorable Matthew Beaton, Secretary
Executive Office of Energy and Environmental Affairs
100 Cambridge Street Suite 900
Boston, MA 02114

Re: EEA #3247: 2016 Logan Airport Environmental Data Report

Dear Secretary Beaton,

On behalf of GreenRoots, I am submitting this comment letter on the 2016 Environmental Data Report (EDR) submitted for Logan Airport by the Massachusetts Port Authority (Massport). GreenRoots provides the following comments regarding this report.

The EDR Process

Massport invests a substantial amount of time and resources into the production of the EDR. Ostensibly, the collected reports over the years provide a documentation of the environmental impacts of the airport and its operations, and the measures taken to lessen or mitigate those impacts. However, for the majority of the residents of East Boston, Winthrop, Revere, Chelsea, and the other communities actually impacted by the ground and air operations of an international airport within their community, these reports are dense collections of complicated data that require specialized skills in several different areas of inquiry to understand, let alone critique. A single public presentation of the results to an audience of fewer than 100 of these residents hardly helps disseminate or elucidate the considerable work that goes into these reports. As such we find it necessary to call into question the process of the development and public release of the EDR, if in fact the intent is to help inform the public, in addition to the relevant permitting and regulatory state agencies, of the environmental impacts of the airport. Quite simply, without additional technical assistance, these reports are overwhelming and, ultimately, of limited utility to the general public.

Additionally, one result of such a voluminous report is the feeling on the part of the public that the copious nature of the report is precisely designed as such in order to have that overwhelming effect. A sudden flood of data, from a couple of years back, with 30 days (frequently, and generously, extended with additional time) for a cogent reply begins to feel like a tactic to prevent any sort of comprehensive response, in light of the lack of a multi-disciplinary engineering firm on retainer to the public. The report itself is obviously presented by a party with a vested interest in a given conclusion – that of compete and effective compliance with environmental laws and a proactive attitude of improvements over all. Bluntly, the EDR is as much beholden to public relations as it is public science. This perception of the EDR leads to cynicism on the part of the public, and fosters an antagonistic relationship between the Port Authority and its residential neighbors. Pounds and pounds of paper which all

GreenRoots • RaicesVerdes
227 Marginal Street, Suite 1, Chelsea, MA 02150
617.466.3076 • www.GreenRootsChelsea.org

conclude that everything at the airport is getting better belies the reality that residents experience every night a plane shakes their windows, or a line of Uber and Lyft cars back up in front of the DeFronzo Center or that a child is hospitalized with an asthma attack.

Even the current process of submitting these written comments in response to the EDR's publication begins to feel rote and an exercise in futility as the conclusion of this process is already foregone. The Secretary will publish the certificate in the Environmental Monitor stating that this report is accepted and we'll wait for the next go around.

Finally, it is concerning that the EDR also serves as the environmental impact reporting requirements for the projects that Massport puts forth before the public as part of the MEPA process. The EDR is not an objective compendium of environmental data and impact analysis. It is a carefully constructed product designed for a specific narrative that justifies the decisions made by management in the operations and expansion of the airport facilities with the priorities clearly focused on bottom line revenue concerns and mitigation limited principally to the public's understanding of the actual health impacts on the neighboring communities.

Suggested Changes

GreenRoots suggests the following changes to the EDR process to address the above concerns.

Real Time Data

For several years there have been many requests from individual residents that live near the airport that some environmental data be made available in real time via the Internet. Currently environmental and operations data is received in a static form within the EDR (as tables in a pdf and at times *images* of tables within a pdf, or as graphs) once every 2-3 years for years past. These modeled data are also aggregated over periods of time in such a manner that clearly ascertaining potential health impacts, even from the modeled data, is difficult. It would be preferred if data could be made available in real time (or near real time) and downloadable from the Internet. In particular air quality data would be desirable to have actually monitored and posted on-line (with necessary quality control and checks). Currently the EDR speaks extensively to the *modeled* levels of *estimated* pollutants without any reference to actual, field measured amounts of the various pollutants in question. The Division of Air Quality Control of the Massachusetts Department of Environmental Protection maintains air quality sensors that are accessible on-line with downloadable data, there is no reason that Massport could not contribute to such a system with additional monitors located around their various properties.

Similarly, aircraft noise monitoring and assessment is also based entirely upon modeled data. At a Community Advisory Committee meeting in the past year the modeling of aircraft noise was presented to a small group of concerned residents. Unbelievably, it was stated by Massport staff that the modeled results are considered more reliable than field measurements of noise and therefore the model is actually used to check the veracity of the actual field data! This would have to be one of the only instances in science where measurements are subservient to model results. As with the air quality model results, the noise model results are aggregated

GreenRoots • RaicesVerdes
227 Marginal Street, Suite 1, Chelsea, MA 02150
617.466.3076 • www.GreenRootsChelsea.org

over periods of time that do not reflect the actual experience of aircraft noise in the community. Again, we recommend that the existing noise monitors have their data available in real time over the internet. These data could easily be combined with data that is publically available from any number of plane tracking applications to help identify noise from non-aircraft sources.

Process

As described above the process of the EDR has become a Kabuki theater of community engagement catered by Spinelli's. The public requires assistance in understanding these enormous reports from a source that is not advocating for the interests of the project proponent, Massport (and "project proponent" is the appropriate term as these reports will form the basis of the EIR requirement for projects that Massport moves forward in the future). Highly technical information from a variety of disciplines alone would be a challenge for most people, but when it is also being presented in such a fashion to drive forward a specific position or interest, it is entirely unreasonable to expect the public to filter through the spin and get to a clear analysis of the data (to the degree that there is any data beyond modeled outputs).

We recommend that the state provide community representatives with technical assistance in order to interpret the report. Whether facilitated by the office of EEA or through a neutral third party would have to be decided in conjunction with residents. Certainly the availability of real time data throughout the year – from air quality and noise to traffic counts and operational data – would allow the public a greater period of time to get familiar with the data, to monitor and spot trends, to develop questions informed by relevant data, and to more effectively participate in this process.

Thank you for the opportunity to submit this comment letter. If you have any questions or concerns, please feel free to contact me at johnw@greenrootschelsea.org.

Very truly yours,

John Walkey
GreenRoots

cc: Stewart Dalzell, Deputy Director, Environmental Planning and Permitting, Massport

GreenRoots • RaicesVerdes
227 Marginal Street, Suite 1, Chelsea, MA 02150
617.466.3076 • www.GreenRootsChelsea.org

This Page Intentionally Left Blank.

Comment #	Author	Topic	Comment	Response
7-1	John Walkey, GreenRoots	Air Quality	It would be preferred if data could be made available in real time (or near real time) and downloadable from the Internet. In particular air quality data would be desirable to have actually monitored and posted on-line (with necessary quality control and checks).	Massport staff have coordinated with the ongoing AIRSense Study. Massport supports ongoing research and collaborates with local scientists by providing data (e.g., aircraft operations, methodologic data, etc.). Massport will support and closely follow the findings of research studies required under the Federal Aviation Administration (FAA) Reauthorization Act of 2018. Specific studies of interest include evaluation of an alternative airplane noise metric; assessment of lead in aviation gasoline and mitigation to reduce ambient lead concentrations; analysis of the relationship between jet aircraft approach and takeoff speeds and corresponding noise impacts on surrounding communities; review of the relationship between aircraft noise exposure and its effects on communities around airports; and the study of potential health and economic impacts of overflight noise (which includes Boston as a case study). See https://www.congress.gov/bill/115th-congress/house-bill/4/text for additional information. Massport is supportive of and is following a research effort undertaken by the FAA Center of Excellence for Alternative Jet Fuels and Environment, Aviation Sustainability Center (ASCENT) attempting to measure ultrafine particle (UFP) emissions related to aircraft and other sources. In July 2017, the research project measured and modeled UFPs for one runway end at Logan Airport. The study is ongoing will reflect both arrival and departure flight paths. Massport will report on the findings of the study in the next Environmental Data Report (EDR), if available.
7-2	John Walkey, GreenRoots	Air Quality	The Division of Air Quality Control of the Massachusetts Department of Environmental Protection maintains air quality sensors that are accessible on-line with downloadable data, there is no reason that Massport could not contribute to such a system with additional monitors located around their various properties.	Massport is always willing to share information collected and modeled for air quality purposes. FAA uses the FAA-required Aviation Environmental Design Tool (AEDT) model to calculate Logan Airport-related emissions. Massport supports FAA research which may include monitoring by research universities. At this time, Massport does not have plans to install air quality monitors at or near Logan Airport.
7-3	John Walkey, GreenRoots	Noise	Again, we recommend that the existing noise monitors have their data available in real time over the internet. These data could easily be combined with data that is publicly available from any number of plane tracking applications to help identify noise from non-aircraft sources.	The current noise monitoring system does not provide real time noise levels or reporting through the interface. In late 2018, Massport contracted for an update to its system, which, when implemented, will provide real time noise levels from equipped remote noise monitor locations.
7-4	John Walkey, GreenRoots	Community Engagement	We recommend that the state provide community representatives with technical assistance in order to interpret the report. Whether facilitated by the office of EEA or through a neutral third party would have to be decided in conjunction with residents.	Massport continually works to refine EDRs and Environmental Status and Planning Reports (ESPRs) to create comprehensive reports that are both readable and succinct but are technically sound. Massport understands the technical nature and complexity in the reporting of some environmental analyses and impacts, but where applicable, uses infographics and charts to aid in the display of data. Chapter 1, *Introduction/Executive Summary* of the EDRs, and now the ESPRs, are translated in Spanish, to provide information to the community. Recently completed Spanish language documents can be found on Massport's website at http://www.massport.com/massport/about-massport/project-environmental-filings/logan-airport/.
7-5	John Walkey, GreenRoots	Data Availability/ Community Engagement	Certainly the availability of real time data throughout the year – from air quality and noise to traffic counts and operational data – would allow the public a greater period of time to get familiar with the data, to monitor and spot trends, to develop questions informed by relevant data, and to more effectively participate in this process.	The yearly EDRs and ESPRs provide frequent and updated data at Logan Airport, which can be found on Massport's website. These reports provide historical context so comparisons can be made and trends can be evaluated. The intent of the ESPR is to provide a review of environmental conditions for the reporting year compared to previous years and provide an outlook into the future of activity and environmental conditions at Logan Airport. Throughout the year, Massport undertakes several initiatives that are reported in EDRs and ESPRs and other reporting documents such as the Annual Sustainability and Resiliency Report. Massport engages directly with the surrounding communities on issues through the Massport Community Advisory Committee (CAC). Massport provides datasets for technical chapters in the appendices of the *2017 ESPR*.

This Page Intentionally Left Blank.

From:	Gillian Anderson
To:	Canaday, Anne (EEA)
Cc:	Gail Miller; Patricia DAmore; Peter Chipman; Jane O"Reilly; Jessica Curtis; Skipdot54; Gabriela Coletta
Subject:	Comments on Boston-Logan International Airport 2016 EDR
Date:	Sunday, June 17, 2018 1:35:20 PM

810 Saratoga St., East Boston, MA 02128
Dear Ms. Canaday, I would appreciate it if you would send an email that indicates you have received these comments.

I am commenting on the Boston-Logan International Airport 2016 EDR. It is obvious to me from the data presented in this report that emissions of NO and CO2 have been steadily increasing since 2011 and that the number of commercial jet flights have also been increasing as has the size of each airplane. As the extra fine particles that are emitted by the jet engines, the diesel engines, brakes and tires of land vehicles at the airport and the idling of taxi, Ueber and Lift vehicles are the most dangerous to the health of your neighbors in East Boston, I am puzzled by the lack of any data referring to them. As the emissions and the number of large jet airplane flights are scheduled to increase, one can only assume that the traffic both air and land, at the airport will produce an increase in these particles. Yet there appear to be no plans to try to stop this inevitable increase (except to try to cover it up by emphasizing data from 1990 as a baseline). I hope MEPA will insist in response to this increase that Massport immediately phase out all diesel vehicles, institute a no-idling policy for taxis, Ueber and Lift vehicles and set a deadline for the use of all electric vehicles at the airport. It should also ban all propeller airplanes which are still burning lead based fuel.

Finally, Massport should establish a fund to reimburse for expenses and lost work time the families with children with asthma. Establishing another park does not adequately reimburse these families for the damage the airport is doing to their children's health and their bottom line (in lost wages and expenses associated with asthma and asthma attacks). Nobody thinks that the economic engine at the airport can or should be stopped but the economic gain of the whole Boston area should not be purchased on the backs of the ill health of East Boston residents. I hope in the one week your director has to read and digest all the comments that we will finally get an adequate response. That would be a game changer. Gillian Anderson

This Page Intentionally Left Blank.

Comment #	Author	Topic	Comment	Response
8-1	Gillian Anderson, East Boston Resident	Air Quality	I hope MEPA will insist in response to this increase that Massport immediately phase out all diesel vehicles, institute a no-idling policy for taxis, Uber and Lyft vehicles and set a deadline for the use of all electric vehicles at the airport. It should also ban all propeller airplanes which are still burning lead based fuel.	Massport is facilitating the replacement of gas- and diesel-powered ground service equipment (GSE) with all-electric GSE (eGSE) by the end of 2027 (as commercially available). Alternative fuels designed to replace lead-containing fuel for general aviation (GA) aircraft are under development. Following testing and certification for use by the Federal Aviation Administration (FAA), the fuels will be available for use and distribution nationwide. However, it is presently unclear if older and high-performance GA aircraft will be able to use the new fuels. Presently, Avgas represents less than 0.01 percent of the overall total of aircraft fuel dispensed. Massport now operates 92 vehicles powered by compressed natural gas (CNG), propane, E85 flex fuel, or operates hybrids powered by gasoline or diesel. The Environmental Status and Planning Report (ESPR) reports on Massport's air quality emissions reduction goals and their status in 2017. There are a total of 115 eGSE in service at Logan Airport. As part of its long-range emission reduction strategy, Massport is working with the airlines to replace 25 percent of all commercially-available GSE with electric alternatives by 2022, and 100 percent by the end of 2027 (as commercially available).
8-2	Gillian Anderson, East Boston Resident	Air Quality	Finally, Massport should establish a fund to reimburse for expenses and lost work time the families with children with asthma. Establishing another park does not adequately reimburse these families for the damage the airport is doing to their children's health and their bottom line (in lost wages and expenses associated with asthma and asthma attacks).	Massport provides an update on the status and findings of the Massachusetts Department of Public Health (MassDPH) Logan Airport Health Study and Massport's air quality studies in the annual Environmental Data Reports (EDRs) and ESPRs. The latest update on the health study is provided in Chapter 7, *Air Quality/Emissions Reduction*. The results of the health studies are also available online at: http://www.mass.gov/eohhs/docs/dph/environmental/investigations/logan/logan-airport-health-study-final.pdf. In response to the MassDPH study recommendations, Massport has undertaken the following initiatives: - Entered into an agreement to provide funding to The East Boston Neighborhood Health Center to help expand the efforts of the Center's Asthma and Chronic Obstructive Pulmonary Disease (COPD) Prevention and Treatment Program in East Boston; - Entered into an agreement with the Massachusetts League of Community Health Centers for the evaluation and assessment of the Asthma and COPD Prevention and Treatment Program, and engagement of community health centers in the North End, Charlestown, Chelsea, and South Boston; - Entered into an agreement with MassDPH to expand or establish the Asthma and COPD Prevention and Treatment Program in South Boston, the North End, Chelsea, and Charlestown in collaboration with Massachusetts General Hospital, South Boston Neighborhood Health Center, and to support MassDPH training on the Community Health Worker assessments.

This Page Intentionally Left Blank.

July 31, 2018

The Honorable Matthew Beaton, Secretary
Executive Office of Energy and Environmental Affairs
Attn: Massachusetts Environmental Policy Act ("MEPA") Office
Anne Canaday, EEA No. 3247
100 Cambridge Street, Suite 900
Boston, MA 02114

Comments on the Boston-Logan International Airport 2016 Environmental Data Report (2016 EDR)

Dear Secretary Beaton:

I remain disappointed and concerned about Massport's inadequate responses to comments I made for the 2015 EDR and in prior years. I focus on 2 of them here: Massport noise monitor information and the effective runway use statistics reported in the PRAS section of the Noise chapter. I request that you pay proper attention to these concerns.

From my 2015 EDR comments

> I think there are several very serious problems with some of Massport's statements, data, analyses, and presentation of results in this and prior EDRs. I have commented with specific examples of these problems for several years now and nothing is done. I don't know how to bring this to your attention – should I write in ALL CAPS, **in bold**, highlighted text, write in red, or perhaps underline the most critical concerns in order to get the MEPA office to pay attention to these comments and those of others, most of whom also write year after year with the same concerns with nothing being done? I have a PhD in statistics, I teach graduate level statistics, and use my training in the research that I do. Massport's clumsiness and distortion of data is of great concern to me because there are decisions being made from this information, decisions that often have very negative consequences for people and communities affected by Massport's noise and air pollution. I think that it is imperative to have an external data audit and analysis done. Please require this now and in the future.

Topic 1. Noise monitor response to comment is inconsistent with information provided during a February 2018 Massport Community Advisory Committee (MCAC) meeting.

One of my comments last year was

On page 6-49, what are the cut off levels and times required for an operation to register at the noise monitors? If they are different by monitor, why?

Massport's response to my comment was that all monitors have a threshold of 65 dB. That is incorrect and misleading. At a February 2018 meeting, Massport employees stated one monitor had a threshold of 63 dB, another had 62 dB. I now know from another information source that few of the monitors are set at a threshold of 65 dB.

Also, at that February 2018 meeting and afterwards, Massport said they would provide this information to the me and to the MCAC. THEY HAVE NOT DONE SO. Please do not sign off on the 2015 EDR unless and until Massport provides this long-time-ago requested information.

Documents and information that I have requested through the MCAC since May 2017 about the Logan monitors and which, at the 2/6/2018 meeting, Massport publicly stated they would provide are listed below. At the meeting, I asked that their statement to comply with my request be made part of that 2/6/2018 public meeting's record. The requested information is:

a. Current threshold and time-above settings for all Massport permanent noise monitors
b. 10-years of past threshold and time-above settings for all Massport permanent noise monitors
c. Reason for changes in the settings over the last 10 years
d. Proportion of primary operation(s) the monitor is meant to pick up that the monitor does pick up, for all monitors for each of the last 3 years.

Topic 2. Effective Use and PRAS Goals Reporting

In previous years, I've asked for the Effective Use statistics reported in the PRAS goals section of Chapter 6 be confirmed or corrected. They do not make sense and are inconsistent with reality.

This table gives statistics on approach runways.

runway	Pras goal	effective use	actual use	act/eff	act-eff
4r/l	21%	26%	35%	1.32%	8%
22l/r	7%	28%	24%	0.87%	-4%
27	22%	20%	23%	1.13%	3%
33l	42%	24%	16%	0.65%	-8%

33L is the overnight arrival runway
effective use counts a plane as 10 if it lands between 10pm and 7am.
both effective and actual use reported here are jets only as in the EDR
year is 2016
when effective>actual it implies more nighttime use

Here's the problem. Runways 4r/4l are used at night just as Runway 22r/22l are used as night but usually not between the hours of midnight and 5am. The comparison between these runway pairs' effective use should be similar but they are not. When a runway's effective use is greater than its actual use, it implies much more nighttime use. This shows up for the approaches to 33L where the effective use is 24% and the actual use is 16% - relatively few planes landing between 10pm and 7am but for the effective use, they each count as 10. Runway 33L is the nighttime noise mitigation approach runway, so its statistics make sense.

However, the effective use for the 22L/R approaches also imply a heavy nighttime use – and that is not reality. One should expect its effective use to be less than the actual, as in the other runways' statistics.

Please do not sign off on the 2015 EDR unless and until Massport provides the following information.

For the 2016 EDR and the 5 EDR/ESPR's prior to the 2016 EDR

1. Counts of jet approaches to each approach runway (as Massport reports monthly online).
2. Counts of jet approaches to each approach runway between the hours of 7am and 10pm.
3. Counts of jet approaches to each approach runway between the hours of 10pm and 7am the next day.
4. Total number of jet approaches.

The same should be done for departures and departure runways.

These counts should show where the data and/or analysis problem is occurring. If it does not, Massport needs to justify why the 22R/L approach runways have so many more occurring between 10pm and 7am than the 4R/L and the 27.

Thank you,

Cindy L. Christiansen, Ph.D.

This Page Intentionally Left Blank.

Comment #	Author	Topic	Comment	Response
9-1	Cindy L. Christiansen, Ph.D., Milton Resident	Noise	I remain disappointed and concerned about Massport's inadequate responses to comments I made for the 2015 EDR and in prior years. I focus on 2 of them here: Massport noise monitor information and the effective runway use statistics reported in the PRAS section of the Noise chapter. I request that you pay proper attention to these concerns.	Massport responds to each comment with the information available at that time. Massport is consistently working towards improving the dialogue between the public, the Massport Community Advisory Committee (CAC), and Massport. Massport welcomes public comment and input on Environmental Data Reports (EDRs) and Environmental Status and Planning Reports (ESPRs), as well as other environmental document.
9-2	Cindy L. Christiansen, Ph.D., Milton Resident	Third-Party Data Analysis	I think that it is imperative to have an external data audit and analysis done. Please require this now and in the future.	Massport regularly engages with the Massport CAC to discuss improvements to data reporting. Modeling is consistently being updated with the latest technology and careful review of these analyses is completed for each report.
9-3	Cindy L. Christiansen, Ph.D., Milton Resident	Noise	On page 6-49, what are the cut off levels and times required for an operation to register at the noise monitors? If they are different by monitor, why? Massport's response to my comment was that all monitors have a threshold of 65 dB. That is incorrect and misleading. At a February 2018 meeting, Massport employees stated one monitor had a threshold of 63 dB, another had 62 dB. I now know from another information source that few of the monitors are set at a threshold of 65 dB.	Noise monitors measure environmental sound by continuously sampling the surrounding sound pressure energy. In order for a monitor to "recognize" an aircraft noise event, the sound pressure must rise above the background (ambient) noise level for a certain amount of time. Each monitor has a threshold value that is set to allow the monitor to discriminate between ambient noise and noise events. Since different monitor sites have different ambient noise levels, the threshold and time values can vary. Nineteen of the 30 monitor sites have the noise event minimum threshold set to 65 dB. Five sites (#20, #22, #24, #25, and #30) have that threshold set at 63 dB, five sites (#2, #6, #8, #13, and #15) have it set at 68 dB, four sites (#7, #10, #1, and #16) have it set at 70 dB, one site (#4) has it set at 75 dB, one site (#9) has it set at 73 dB, and one site (#28) has it set at 60 dB. The system will register a noise event if the noise level is above the minimum threshold for 10 consecutive seconds; the event will be tagged as an aircraft event if there is an aircraft operation nearby occurring at that time.
9-4	Cindy L. Christiansen, Ph.D., Milton Resident	Noise Data Request	Also, at that February 2018 meeting and afterwards, Massport said they would provide this information to the me and to the MCAC. THEY HAVE NOT DONE SO. Please do not sign off on the 2015 EDR unless and until Massport provides this long-time-ago requested information.	Please see response to comment 9-3 above.
9-5	Cindy L. Christiansen, Ph.D., Milton Resident	Activity Level / Noise	Please do not sign off on the 2015 EDR unless and until Massport provides the following information. For the 2016 EDR and the 5 EDR/ESPR's prior to the 2016 EDR 1. Counts of jet approaches to each approach runway (as Massport reports monthly online). 2. Counts of jet approaches to each approach runway between the hours of 7am and 10pm. 3. Counts of jet approaches to each approach runway between the hours of 10pm and 7am the next day. 4. Total number of jet approaches. The same should be done for departures and departure runways. These counts should show where the data and/or analysis problem is occurring. If it does not, Massport needs to justify why the 22R/L approach runways have so many more occurring between 10pm and 7am than the 4R/L and the 27.	Table H-3 in the noise appendix of the *2016 EDR* presents counts of all aircraft operations (jet and non-jet) by runway, separated by arrival/departure and by day/night (with night defined as 10:00 PM to 7:00 AM). Table H-3 provides data for both 2016 and 2015 and that same table in prior EDRs provides the same information for prior years. As noted, the noise office publishes jet-only runway use data monthly. The effective use of Runway 33L and Runway 22L for arrivals is higher than the actual use, as the commenter noted, due to higher nighttime use of those runways. For Runway 27 and Runways 4R/L, the effective use is lower than actual use due to lower nighttime use of those runways. Table H-5a in the noise appendix provides detailed runway use, broken down by aircraft groupings and separated by arrival/departure and by day/night. Runway usage is dependent on many factors including weather conditions, fleet mix, safety requirements, and varies according to those factors.

This Page Intentionally Left Blank.

James J. Morgan
1025 Hancock Street, Unit 14G
Quincy, MA. 02169
jjmorgan02169@gmail.com
617.522.2018

21 June 2018

Matthew Beaton, Secretary
Executive Office of Energy and Environmental Affairs
Attn: MEPA Office
Anne Canaday, EEA No 3247
100 Cambridge Street, Suite 900
Boston, MA 02114

Dear Secretary Beaton:

Thank you for the opportunity to reply to the Massachusetts Port Authority's 2016 Environmental Data Report (EDR). I doubt that you will read many responses like mine. My comments here are largely a personal testimony of the devastating consequences Massport's unaccountable and unregulated actions had on me. Please understand that every word written here is true, unexaggerated, and can be documented:

It is no understatement for me to say that the <u>FAA's and Massport's NextGen system have robbed me of my home, health, and happiness.</u> Furthermore, as I will explain, I contend that these actions are <u>illegal.</u>

In 2002, I achieved a lifelong goal when I purchased a condo near Egleston Square in Jamaica Plain, close to the Roxbury line. It was not just my biggest financial investment, which I lovingly cared for and renovated in every detail. My home became an anchor for me where I navigated life's ups and downs. Over time, it became filled with memories both happy and sad. I was also actively involved in my community, knew practically everyone, and even their dogs' names.

Along with my neighbors, for most of these fifteen years, I lived there in peace and quiet. I was unbothered by the planes, which departed Runway 27, and flew at reasonable heights over nearby Franklin Park. Beginning several years ago, when Logan's flight paths and the altitude at which the planes flew were altered, this all changed.

With the ferocity of a blitzkrieg, during the spring of 2017 my formerly tranquil residence, although it was located at considerable distance from the airport, was strafed day after day by an unending succession of low-flying planes, barely above the treetops. (Attachment 1) Often, the siege began at 5 a.m. and lasted for hours and hours on end. Almost overnight and without warning, my home became a living hell.

The ear plugs and a white noise machine I purchased provided no relief. Living under the aviation equivalent of the Southeast Expressway, my health rapidly declined. (I am a semi-retired man with a cardiovascular condition who works nights part-time at a college.) Due to sheer exhaustion from being awakened almost daily at 5 a.m., I began missing work frequently, and recall several occasions when I returned late, and almost collapsed on the way home from my job. I exhibited a long list of symptoms that included noise sensitivity, being startled easily, insomnia, loss of balance, faintness, irritability, memory loss and forgetfulness, trembling, depression, anxiety, auditory hallucinations, fatigue, lack of energy, intestinal disorders, pounding heart, bad dreams, fits of crying, frequent headaches, hopelessness, a sense of separation and unreality, tension in my shoulders, neck, and back, decreased libido, nervous tics, a quivering voice, social withdrawal, and eventually, as I will explain, paranoia.

Finally, in July, 2017, I sought medical help. I kept my suicidal impulses to myself in order to avoid being institutionalized. My physician told me that I was experiencing "situational anxiety," and attributed most of my health issues to sleep deprivation. The doctor prescribed tranquilizers, something I have never taken in my life. And it was necessary to experiment with different medications, since I reacted badly to the Ambien I was first given. He also suggested that I take antidepressants, but I declined.

During this same time period, I tried to defend my home, and responded proactively to the crisis I was experiencing. I spoke at a meeting of the Massport Community Advisory Committee (MCAC), joined an online community of similarly affected citizens called "*Boston Fair Skies South*," contacted the media, wrote letters to the FAA, Massport's Board of Directors, the agency's corporate counsel, and various elected representatives. In particular, I implored the Mayor and Boston City Council to duplicate the actions of Phoenix officials who successfully sued the FAA to stop the NextGen project there. I also filed countless, mostly online noise complaints with Massport but they fell on deaf ears.

If laboratory animals were subjected to the same levels of sleep deprivation and noise, there would a public outcry, and criminal prosecutions. But the situation persisted without an iota of relief, and my outrage grew. The complaints that I filed nearly every day became angrier and angrier. To be honest, I did not hesitate to express myself in uncensored language, or to use middle finger emojis, as would anyone whose life had been ripped apart by such a cruel attack.

On July 20, I filed a civilly worded, formal request with the Public Records Division of the Secretary of the Commonwealth for quantitative data about the number of flights and their altitudes. (Attachment 2) In

addition, I sought specific, relevant information about air and noise pollution. Lastly, I raised issues of environmental justice, and asked Massport to provide evidence that these flight changes were not purposefully targeted at the disadvantaged, minority, and vulnerable community where I lived.

In response, on August 10, 2017, I received a letter from Frank Iacovino, Massport's Noise Abatement Office Manager, stating that I "*must cease sending abusive, threatening and vulgar communications to Massport and its employees."* On August 16, this was followed up by a phone call from a Massachusetts State Police officer who threatened me with arrest in violation of Ch. 269-14A, "Annoying or Obscene Communications," and Ch. 265-43A, "Criminal Harassment." (In this regard, please allow me to explain that I never "threatened" anyone with anything other than legal or direct action.)

Subsequently, I remember how the sound of a police siren, firetruck or ambulance filled me with fear. I envisioned myself handcuffed, arrested, and locked up at the hands of Massport's troopers. I began to think that I was on the brink of complete psychosis. (In retrospect, I now see that Massport's threats were an attempt to frighten me into silence and submission.)

The Secretary of the Commonwealth's office kindly supported my right to this information, and told me that the frank language that I had used in my complaints was "irrelevant." However, after multiple appeals, during which Massport never complied, I ultimately received a letter on October 23 from Michelle Kalowski, Acting Chief Legal Counsel, who fraudulently contended that "Massport is not in possession of any documents that are responsive to your request." This, of course, is a bold-faced lie since the EDR, at review here, is replete with proof to show that Massport keeps careful statistics about all of its operations.

But the biggest falsehood throughout this ordeal was that Massport repeatedly made the Orwellian assertion that, "*The jet departure procedure for RW27 has been in place since 1996."* I was confounded by Massport's continuous denial of reality, and its ridiculous, rote position that nothing had changed since then.

More honestly, in a June 23, 2017 *Boston Gl*obe article (*As Logan runway work ends, communities eagerly await plane noise study*) Thomas Glynn, Chief Executive Officer of Massport, candidly acknowledged, *"The increased frequency of certain routes has made things worse for residents with the misfortune of living underneath. While some areas now experience fewer flights, the noise can be "unrelenting" for those residents, he said."*

Later, I became aware of a noise study called "*27 33L RNAV Cumulative Impact*." The key operating phrase in this document is "*no significant impact*," which is used ad nauseum throughout. (The report only measured decibel levels and not the "unrelenting" frequency of flights.) Likewise, it bore no resemblance to the reality that I was experiencing.

When I finally got my hands on the 1996 Record of Decision (ROD) for Runway 27, I experienced an "aha" moment. It unequivocally states:

"The FAA has selected the Final Alternative (or Preferred Procedure) of the Final Environmental Impact statement. This alternative is expressed in land use as follows: Maintain runway heading until reaching the

*World Trade Center, then left to overfly the southern end of Ft. Point Channel, the Massachusetts Avenue intersection of the Southeast Expressway, areas of Roxbury, **the center of Franklin Park** and Forest Hills Cemetery, and then turn northerly, westerly, or southerly in accordance with the destination airport."*

It became perfectly clear to me, Mr. Beaton, when I read this why Massport has engaged in this calculated program of disinformation. The agency is not in compliance with this legally binding document, which originally authorized, and specified the terms of its use of Runway 27. Despite Massport's claim, no, I was not hallucinating! Until recently, planes departing Logan had flown over the park and not at ridiculously low altitudes directly over my house.

Neither MEPA nor any other governing agency has held Massport accountable for violating the law. In the absence of a regulatory body willing to protect its citizens, a virtual embargo on media coverage, a compromised and impotent MCAC, and without any credible political support, I realized that the situation was hopeless. And as I have described, Massport's unchallenged power is so imperious that it can even flaunt the Public Records laws, and threaten those who challenge its authority with arrest. I understood that I was one of the "unfortunates" Mr. Glynn had referred to, and was living under what has come to be known as a "sacrificial corridor."

Ultimately, I realized I was fighting a losing battle, surrendered, and put my home up for sale. I was worried about the depreciated value of my place, and joked with the broker that "he needed to find a deaf buyer." Nonetheless, I managed to sell my condo in December, 2017. This was an extremely sad, difficult, and stressful process during which I put most of my belongings in storage, couch surfed with friends, slept on air mattresses, and mostly subsisted on microwave and take-out meals. In February, 2018, I moved to Quincy where I was forced to start all over.

Although I have recovered considerably, I think that I will always be traumatized by this experience, and will never quite be the same. Indisputably, I lost a year of my life! From where I live now, I can see the planes that night and day torture the poor residents of Milton. As Massport has been empowered to rule the skies surrounding Boston with absolute impunity, I realize that it only has to arbitrarily and capriciously alter its flight patterns by a few degrees, and I could again find myself in the same position that I fled, and be driven a second time from my home.

In conclusion, I must admit that I have not read the sprawling, 1000 page plus EDR in its entirety. Suffice it to say that Chapter 6, Noise Abatement begins with the absurdly deceitful declaration that, "*The Massachusetts Port Authority (Massport) strives to minimize the noise effects of Boston-Logan International Airport (Logan Airport or the Airport) operations on its neighbors through a variety of noise abatement programs, procedures, and other tools."*

Buried in the Executive Summary (page 1-31) are the following telling statistics: "*In 2016, Massport received 38,045 noise complaints from 83 communities, compared to 17,685 in 2015 from 84 communities*," an over 100% increase! Considering that this data is now almost two years old and was gathered before the complete deployment of NextGen, the figures have more than likely at least doubled again by now. As long ago as November 24, 2015, the Boston Globe (FAA Hearing More Noise

Complaints Over Logan Airplane Noise) wrote, "*The number of complaints about airplane noise has skyrocketed since new GPS-generated flight paths at Logan Airport took effect*."

Additionally, the voluminous data provided in Chapter 7, Air Quality/Emissions Reduction is equally dated. Now, with the full implementation of NextGen, there is no mention whatsoever about the health and air pollution effects of an unprecedented number of planes flying at low altitudes and repeatedly spewing toxic plumes over a highly contained area.

In closing, Sir, I am under no illusion that a single word I have written here will change anything. Until now, the Executive Office of Energy and Environmental Affairs has totally abnegated its responsibility to protect the citizens of the Commonwealth from Massport's egregious actions. I have learned the sad lesson that justice does not exist for those without wealth and powerful connections.

In the unlikely event that you would care to prove me wrong, please allow me to make two suggestions. First, your office should take immediate measures to enforce the legally binding 1996 ROD, and demand that Massport's flights revert to their pre-NextGen patterns. Secondly, I urge you to file a class action suit on my behalf and for others whose lives have been irreparably damaged.

Sincerely,

James J. Morgan

James J. Morgan

Attachments: Photo, Public Records Request

James J. Morgan
14 Forest Hills Street, #2
Jamaica Plain, MA. 02130
(617) 522-2018
jjmorgan02130@yahoo.com

20 July 20 2017

Records Access Officer
Massachusetts Port Authority
One Harborside Drive, Suite 200S
East Boston, MA. 02128-2909

Re: Massachusetts Public Records Request

Dear Records Access Officer:

This is a request under the Massachusetts Public Records Law (M. G. L. Chapter 66, Section 10). I am requesting that I be provided a copy of the following records:

1.) What is the maximum number of flights per minute for RW27? Correspondingly, what is the maximum number of flights per hour for RW27?
2.) What was the total number of flights from RW27 on July 5, 2017 between 7 a.m. and 8 a.m.?
3.) What was the total number of flights from RW27 on July 5, 2017 between 5 a.m. and 1 p.m.?
4.) On July 5, 2017 (and on numerous other dates), flights from RW27 followed a consistent trajectory that flew over Montebello Road, Olmstead Street, and Peter Parley Road on their way towards Roslindale and Hyde Park. On July 5, 2017 what was the lowest altitude that these planes reached when they were at their closest proximity to my address at 14 Forest Hills Street?
5.) Prior to the implementation of this new flight path, what was the altitude of flights at a comparable distance from RW27 at their closest proximity to my address at 14 Forest Hills Street? In other words, how many feet lower are they now?
6.) Since these substantive changes to the flightpaths from RW27 were put into effect which specific areas of Boston are experiencing less air traffic? (Provide maps and/or quantitative data)
7.) Since these substantive changes to the flightpaths from RW27 were put into effect which areas of Boston are experiencing more air traffic? (Please provide maps and/or quantitative data)
8.) What was the decision making process behind the new flightpaths from RW27?
9.) Provide evidence that these new flightpaths, which pass almost directly over Egleston Square (avoiding whiter and richer portions of Jamaica Plain), were not purposefully targeted to exploit a disadvantaged, minority, and vulnerable community?
10.) Prior to this substantive change to flights departing RW27, were studies were conducted to measure the effects on air quality of hundreds of low-flying aircraft passing a concentrated area during a compact period of time? If so, provide evidence that this new procedure does not endanger public health.

I recognize that you may charge reasonable costs for copies, as well as for personnel time needed to comply with this request.

The Public Records Law requires you to provide me with a written response within 10 business days. If you cannot comply with my request, you are statutorily required to provide an explanation in writing.

Sincerely,

James J. Morgan

Olmstead Street, Jamaica Plain, 6/27/17

Comment #	Author	Topic	Comment	Response
10-1	James J. Morgan, Quincy Resident	Noise	First, your office should take immediate measures to enforce the legally binding 1996 ROD, and demand that Massport's flights revert to their pre-NextGen patterns.	The RNAV procedure implemented for Runway 27 complies with the 1996 Runway 27 Environmental Impact Statement (EIS) Record of Decision (ROD). The use of RNAV is the technology that has allowed the Federal Aviation Administration (FAA) to comply with the ROD.
10-2	James J. Morgan, Quincy Resident	Noise/ Runway Use	What is the maximum number of flights per minute for RW27? Correspondingly, what is the maximum number of flights per hour for RW27?	The maximum number of flights is dependent on many factors including weather conditions, fleet mix, safety requirements, and varies according to those factors.
10-3	James J. Morgan, Quincy Resident	Noise/ Runway Use	What was the total number of flights from RW27 on July 5, 2017 between 7 a.m. and 8 a.m.?	Thirty-two flights departed from Runway 27 between 7:00 and 8:00 AM on July 5, 2017.
10-4	James J. Morgan, Quincy Resident	Noise/ Runway Use	What was the total number of flights from RW27 on July 5, 2017 between 5 a.m. and 1 p.m.?	Two-hundred and four flights departed from Runway 27 between 5:00 AM and 1:00 PM on July 5, 2017.
10-5	James J. Morgan, Quincy Resident	Noise / Flight Paths	On July 5, 2017 (and on numerous other dates), flights from RW27 followed a consistent trajectory that flew over Montebello Road, Olmstead Street, and Peter Parley Road on their way towards Roslindale and Hyde Park. On July 5, 2017 what was the lowest altitude that these planes reached when they were at their closest proximity to my address at 14 Forest Hills Street?	An examination of radar data shows that the majority of Runway 27 departures on July 5, 2017 (about 90 percent) ranged from 2,600 feet to 4,400 feet in altitude at their point of closest approach to that address. The minimum altitude observed was approximately 2,300 feet. All flights were consistent with FAA flight procedures.
10-6	James J. Morgan, Quincy Resident	Noise / Flight Paths	Prior to the implementation of this new flight path, what was the altitude of flights at a comparable distance from RW27 at their closest proximity to my address at 14 Forest Hills Street? In other words, how many feet lower are they now?	There is not a new departure flight path from Runway 27. The information above pertaining to Runway 27 departure altitudes is the same, along with the minimum altitude. Figures displaying the departure flight paths from Runway 27 are provided in Chapter 6, *Noise Abatement* of each Environmental Data Report (EDR) and Environmental Status and Planning Report (ESPR) published including the most recent *2017 ESPR*.
10-7	James J. Morgan, Quincy Resident	Noise / Flight Paths	Since these substantive changes to the flightpaths from RW27 were put into effect which specific areas of Boston are experiencing less air traffic? (Provide maps and/or quantitative data)	There is not a new departure flight path from Runway 27. Figures displaying the departure flight paths from Runway 27 are provided in Chapter 6, *Noise Abatement* of each EDR and ESPR published including the most recent *2017 ESPR*.
10-8	James J. Morgan, Quincy Resident	Noise / Flight Paths	Since these substantive changes to the flightpaths from RW27 were put into effect which areas of Boston are experiencing more air traffic? (Please provide maps and/or quantitative data)	There is not a new departure flight path from Runway 27. Figures displaying the departure flight paths from Runway 27 are provided in Chapter 6, *Noise Abatement* of each EDR and ESPR published including the most recent *2017 ESPR* .
10-9	James J. Morgan, Quincy Resident	Noise / Flight Paths	What was the decision making process behind the new flightpaths from RW27?	There is not a new departure flight path from Runway 27. The departure path was established by an environmental and community process, and confirmed in the subsequent FAA ROD. The procedure was modified by the FAA to comply with the 1996 ROD .
10-10	James J. Morgan, Quincy Resident	Noise / Environmental Justice	Provide evidence that these new flightpaths, which pass almost directly over Egleston Square (avoiding whiter and richer portions of Jamaica Plain), were not purposefully targeted to exploit a disadvantaged, minority, and vulnerable community?	The Runway 27 procedure has not changed over the Jamaica Plain area.
10-11	James J. Morgan, Quincy Resident	Air Quality / Flight Paths	Prior to this substantive change to flights departing RW27, were studies were conducted to measure the effects on air quality of hundreds of low-flying aircraft passing a concentrated area during a compact period of time? If so, provide evidence that this new procedure does not endanger public health.	There is not a new departure flight path from Runway 27. The information above pertaining to Runway 27 departure altitudes is the same, along with the minimum altitude. Figures displaying the departure flight paths from Runway 27 are provided in Chapter 6, *Noise Abatement* of each EDR and ESPR published including the most recent *2017 ESPR*.

This Page Intentionally Left Blank.

From:	Luke Preisner
To:	Canaday, Anne (EEA)
Cc:	mgove@massport.com; Peter Houk
Subject:	2016 Massport EDR Comments
Date:	Monday, June 18, 2018 9:38:33 AM

To whom it concerns:

As a concerned private citizen and one affected by runway 33L departures and 15R arrivals in Medford, I have reviewed the 2016 EDR and would like provide specific comments and corresponding questions on those parts of the EDR which are most important to my neighborhood. These are being provided ahead of the deadline but please confirm they have been received and entered.

I look forward to seeing replies to the comments and questions below.

Sincerely,
Luke Preisner
140 Forest Street, Medford MA

Page 275 of the EDR

"In 2016, Runway 15R-33L was the preferred runway to use at night to reduce nearby community noise, with arrivals to Runway 33L and departures from Runway 15R (known as head-to-head procedures), thus keeping flights over Boston Harbor (although these flights do eventually fly over South Shore communities)."

My Comment: Our experience in Medford has been that overnight flights are particularly invasive and detrimental to sleep. We understand that Logan does not have nighttime curfews and due to Federal ANCA restrictions, curfews are not a reasonable possibility. Unfortunately, we have no idea of how often the preferred noise abatement runway configuration is used. The EDR does not appear to offer this information. We believe the particular FAA order associated with the noise abatement policy is BOS ATCT 7040.1H
Corresponding Question: How often, as a fraction of total night time operations, was the preferred nighttime configuration (DEP:15R ARR:33L) used in 2016?

Pages 300-306 of the EDR

"When changes in noise exposure are predicted through modeling, it is important to substantiate these modeled findings with actual noise measurements, such as those taken with Massport's permanent noise
monitoring system."

My Comment: The EDR does not provide evidence that the Permanent Noise Monitor network is itself effective at picking up aircraft noise.
Corresponding Question 1: Aside from the daily calibration pulses used by the noise monitor network, which ensure precision, how does Massport ensure the accuracy of noise monitor network? Is there a regular activity that Massport performs which checks how well noise spikes measured by the noise monitor network correlate to actual aircraft operations?
Corresponding Question 2: If the noise monitoring network is not accurate then what are the implications for the modeled noise contours? Could the noise contours possibly be inaccurate as well?

General Statement about Waypoint Location

My Comment: The EDR does not explain why the TEKKK fly-by waypoint, which was added as part of the 33L RNAV SID, is right above one of Medford's middle schools - and right next to three other schools (Roberts Elementary, McGlynn Elementary and McGlynn Middle). We have a high density of students very near TEKKK, almost 2000 children.

Corresponding Question 1: The current location of the TEKKK is in extremely close proximity to a pair of public schools in Medford; it is nearly directly overhead. TEKKK could easily have been located over the nearby Mystic River. Are the children counted in the noise exposure populations?

Corresponding Question 2: How does the decision to place TEKKK almost directly over public schools comport with FAR part 150?

<<<<<<<<<<<<<<<<<END>>>>>>>>>>>>>>>>>>>>>>>>>

Comment #	Author	Topic	Comment	Response
11-1	Luke Preisner, Medford Resident	Noise	How often, as a fraction of total night time operations, was the preferred nighttime configuration (DEP:15R ARR:33L) used in 2016?	Runway configuration data for 2016 tallied by hour indicate that the configuration of Departures from Runway 15R and Arrivals to Runway 33L occurred during 476 out of 1,825 operations between midnight and 5:00 AM. Wind and weather conditions influence the utility of the runway configuration.
11-2	Luke Preisner, Medford Resident	Noise	Aside from the daily calibration pulses used by the noise monitor network, which ensure precision, how does Massport ensure the accuracy of noise monitor network? Is there a regular activity that Massport performs which checks how well noise spikes measured by the noise monitor network correlate to actual aircraft operations?	Massport regularly reviews the noise measurement data and investigates abnormally loud events that have been correlated with aircraft overflights.
11-3	Luke Preisner, Medford Resident	Noise	If the noise monitoring network is not accurate then what are the implications for the modeled noise contours? Could the noise contours possibly be inaccurate as well?	Annual day-night average sound level (DNL) contours are generated using a complex Federal Aviation Administration (FAA)-required computer model (the Aviation Environmental Design Tool [AEDT]) using aircraft operations data, runway use data, and flight track geometry as inputs. Monitor data has no effect on noise contour calculations.
11-4	Luke Preisner, Medford Resident	Noise	The current location of the TEKKK is in extremely close proximity to a pair of public schools in Medford; it is nearly directly overhead. TEKKK could easily have been located over the nearby Mystic River. Are the children counted in the noise exposure populations?	The noise exposure population impact assessments count only residents (quantified by the most recent U.S. Census data) living inside the DNL contour lines.
11-5	Luke Preisner, Medford Resident	Noise	How does the decision to place TEKKK almost directly over public schools comport with FAR part 150?	The design of air traffic procedures is not related to FAA Part 150. The Part 150 process develops DNL contours and develops steps to reduce noise levels within the DNL 65 dB contour. The TEKKK waypoint is well outside the DNL 65 dB contours. The Runway 33L RNAV procedure is documented and evaluated in the FAA Runway 33L RNAV Environmental Assessment.

This Page Intentionally Left Blank.

Nancy S. Timmerman, P.E.
Consultant in Acoustics and Noise Control
25 Upton Street
Boston, MA 02118-1609
(617)-266-2595 (Phone & FAX) ; (617)-645-0703 (Cell)
nancy.timmerman@alum.mit.edu
nancy_timmerman@comcast.net

June 22, 2018

The Honorable Matthew A. Beaton, Secretary
Executive Office of Energy and Environmental Affairs
Attn: MEPA Office
Anne Canaday, EEA No. 3247
100 Cambridge Street, Suite 900
Boston, MA 02114

Subject: EOEA No. 3247 – Boston-Logan Airport 2016 Environmental Data Report (EDR)

Dear Secretary Beaton:

These comments are being transmitted by email. I have reviewed the 2016 Environmental Data Report (EDR), EOEA #3247 and offer the following comments and questions.

On page 3-18, Figure 3-5, Massport discusses the development of airport edge buffers, whose purpose is to relieve the adjacent communities. These efforts likely reduce the actual noise measured at the NOMS sites. The comparison of measured versus modeled for 2016 (Pages 6-42 to 6-44 and Table 6-9) show mostly negative values for sites which are far away, in contradiction to what is said on Page 6-42. The farther-out sites seem to be better modeled in 2016 with AEDT.

What happens to sites which have gone out of service? Site 12 (East Boston Yacht Club) has been out since 2010 (in this report). It would appear the Site 14 (Jeffries Point) may have had issues in 2016 since the difference is 16 dB. Site 1 (South End) has been out of service since March.

The trend, with RNAV procedures, no nighttime restriction, and increased operations, has been continued increase in noise impact from Logan. Even with data from 2015 and 2016, the DNL at many noise monitoring locations, is above 65. While efforts have been made to reduce the impact, the outlook is for more nighttime flights, and severe impact when a runway combination affecting the communities around Logan.

Thank you for the opportunity to comment on this report.

Sincerely,

Nancy S. Timmerman, P.E.

Cc: S. Dalzell, MPA

This Page Intentionally Left Blank.

Comment #	Author	Topic	Comment	Response
12-1	Nancy S. Timmerman, P.E., Consultant in Acoustics and Noise Control	Noise	The comparison of measured versus modeled for 2016 (Pages 6-42 to 6-44 and Table 6-9) show mostly negative values for sites which are far away, in contradiction to what is said on Page 6-42.	If "far away" is defined as over 4 miles, that would mean Sites 17-29 (13 sites); of these, only three show negative values in the far right column, so the statements on Page 6-42 do appear to be accurate.
12-2	Nancy S. Timmerman, P.E., Consultant in Acoustics and Noise Control	Noise	What happens to sites which have gone out of service? Site 12 (East Boston Yacht Club) has been out since 2010 (in this report). It would appear the Site 14 (Jeffries Point) may have had issues in 2016 since the difference is 16 dB. Site 1 (South End) has been out of service since March.	The monitor at Site 1 was removed in May 2017 at the request of the property owner. Massport is reviewing options for relocation. Site 12 had to be removed in 2010 and after completion of the relocation and permitting process, started to collect noise information on 2/12/18. Its new location is on Massport property (Wood Island Bay Edge Park) at 123 Coleridge St., East Boston. Site 14 is operational, but had issues in both 2016 and 2017. Site 18 had power outage and noise analyzer issues in 2016, which were resolved in September 2017. Site 26 was severely damaged by a Hull Highway vehicle involved with repaving work at Hull High School. It was non-operational for 2016, but was re-installed and resumed operation in September 2017. Site 1 was fully operational during 2016 but went out of service in the first half of 2017; Massport is currently reviewing options for relocating that monitor.

This Page Intentionally Left Blank.

C

Proposed Scope for the *2018/2019 EDR*

PROJECT NAME: Logan Airport 2018/2019 Environmental Data Report (EDR)

PROJECT LOCATION: Boston Logan International Airport, East Boston, Massachusetts

EOEA NUMBER: 3247

PROJECT PROPONENT: Massachusetts Port Authority (Massport)

Massport formally requests consideration of combining the *Logan Airport 2018/2019 Environmental Data Report (EDR)* for public review and comment. The *2018/2019 EDR* would follow the *2017 Environmental Status and Planning Report (ESPR),* which was filed in July 2019. This approach is comparable to the previous *2011 ESPR* filing and subsequent combined *2012/2013 EDR*. Similar to the *2011 ESPR*, the level of effort involved in preparing an ESPR to include new forecast and planning studies is considerably greater than an annual EDR. To ensure the following years are adequately reported on given the July filing date of the *2017 ESPR*, this combined approach will allow time for an inclusive analysis of the current years. As directed by the Secretary of the Executive Office of Energy and Environmental Affairs (EEA), Massport will continue to use this process to evaluate the cumulative impacts associated with Logan Airport activities through preparation of an ESPR approximately every five years with data updates annually through the EDRs. The next ESPR will report on future conditions and will provide the most recent passenger and operations forecasts for Logan Airport and compare to historic trends. Massport will continue to provide updates on key environmental topics on the Massport website (http://massport.com/massport/about-massport/project-environmental-filings/).

Purpose of the Logan Airport *2018/2019 EDR*

For over three decades, the Logan Airport EDRs and ESPRs have provided information to agencies and the public on planning activities, aircraft operations and passenger activity levels, and Massport initiatives at Logan Airport. The 2018/2019 EDR will provide an update on conditions at Logan Airport for calendar years 2018/2019. The EDR will continue to serve as a background/context against which projects at Logan Airport can be evaluated. It also will report on the cumulative effects of Logan Airport operations and activities, compared to previous years, as appropriate.

The EDR/ESPR process was developed to allow individual projects at Logan Airport to be considered and analyzed in the broader, Airport-wide context. The EDRs and ESPRs serve as the baseline analyses for project-specific environmental reviews and provide a forum for updates on Massport's mitigation program. This

2017 ESPR is part of a well-established, state-level environmental review process that assesses Logan Airport's cumulative environmental impacts. The process provides a context against which individual projects at Logan Airport meeting state and federal environmental review thresholds are evaluated on a project-specific basis. The Airport-wide and project-specific environmental review processes are described in this report. Where appropriate, Massport will continue to identify and address any longer-term aviation and environmental trends in both EDRs and ESPRs. As directed in the Secretary's Certificate on the Terminal E Modernization Project Environmental Notification Form (ENF), the EDR/ESPR will continue to be the forum to address cumulative, Airport-wide impacts. By providing the Airport-wide context for air quality, noise, ground transportation, and water quality, the EDRs/ESPRs help focus the review processes for state ENFs and, if necessary, Environmental Impacts Reports (EIRs). In this manner, Massport ensures that segmented project review does not occur in the context of Massachusetts Environmental Policy Act (MEPA) review of projects at Logan Airport. The EDRs/ESPRs also provide context for federal National Environmental Policy Act (NEPA) reviews by the Federal Aviation Administration (FAA) serving as the lead federal agency. In short, the EDRs/ESPRs provide a planning context which complements the individual project-specific filings. As directed in the Secretary's Certificate on the Terminal E Modernization Project ENF, the EDR/ESPR will continue to be the forum to address cumulative, Airport-wide impacts.

Contents of the *2018/2019 EDR*

Generally, the *2018/2019 EDR* will follow the format of the *2016 EDR*, presenting an overview of the role of Logan Airport in the regional planning context. Similar to the *2012/2013 EDR* reporting on two years, the *2018/2019 EDR* will report on 2018 and 2019 passenger and aircraft operation activity levels. This will be followed by a status report on Massport's proposed planning initiatives, projects, and mitigation. In this way, Massport will provide necessary background information to allow the reviewer to understand the environmental policies and planning which form the context of the environmental reporting, technical studies, and environmental mitigation initiatives at Logan Airport.

The technical studies in the *2018/2019 EDR* will include reporting on and analysis of key indicators of airport activity levels, the regional transportation system, ground access, noise, air quality, water quality and environmental management, and project mitigation tracking. Sustainability initiatives are included throughout the document. Each chapter's contents are described below.

Chapter 1. Introduction/Executive Summary

This chapter of the *2018/2019 EDR* will include:

- Highlights of 2018 and 2019 planning and environmental conditions;
- Overview of Logan Airport and place it in its environmental, geographic, and regulatory context;
- Overview of the EDR/ESPR cycle;
- Highlights of passenger activity levels and aircraft operations;
- Discussion of local, regional, and national economic impacts;

- Description of the analysis framework for the environmental reporting and technical studies to be conducted;
- Overview of the Logan Airport planning initiatives and projects;
- Overview of sustainability initiatives at Logan Airport; and
- Organization of the *2018/2019 EDR*.

A Spanish version of the Executive Summary for the *2018/2019 EDR* will be prepared and included in the document.

Chapter 2. Activity Levels

The primary purpose of this chapter will be to report on airport activity levels for 2018 and 2019, including:

- Aircraft operations, including fleet mix and scheduled airline services at Logan Airport;
- Domestic and international passenger activity levels;
- Cargo and mail volumes;
- Compare 2018/2019 aircraft operations, cargo/mail operations, and passenger activity levels to 2017 activity levels; and
- Report on national aviation trends in 2018/2019 and compare to trends at Logan Airport.

Chapter 3. Airport Planning

Massport continues to assess planning strategies for improving Logan Airport's operations and services in a safe, secure, more efficient, and environmentally sensitive manner. As owner and operator of Logan Airport, Massport also must accommodate and guide tenant development. This chapter will describe the status of planning initiatives for the following areas:

- Ground Transportation and Parking;
- Terminals;
- Airside Planning;
- Service Areas;
- Airport Buffers and Open Space; and
- Energy, Sustainability, and Resiliency.

Massport is planning for the ongoing improvement of Logan Airport facilities as well as enhancing access to and from the Airport. The chapter will report on the status of projects implemented within the boundaries of Logan Airport either by Massport, its tenants, or other state entities. The chapter will also report on the status

and effectiveness of the ground access related changes including roadway and parking projects, which consolidate and direct Airport-related traffic to centralized locations and minimize Airport-related traffic on external streets in adjacent neighborhoods.

Chapter 4. Regional Transportation

The *2018/2019 EDR* will describe Logan Airport's role in the region's intermodal transportation system by reporting on the following:

Regional Airports

- Regional airport operations, passenger activity levels, and schedule data within an historical context;
- Status of plans and new improvements as provided by the regional airport entities;
- Regional economic factors;
- Ground access improvements to the regional airports; and
- The role that Worcester Regional Airport and Hanscom Field play in the regional aviation system and Massport's efforts to promote these airports.

Regional Transportation System

- Massport's role in managing regional aviation facilities;
- Massport's cooperation with other transportation agencies to promote efficient regional highway and transit operations; and
- Report on metropolitan and regional rail initiatives and ridership.

Chapter 5. Ground Access to and from Logan Airport

The chapter will report on 2018 and 2019 conditions and provide a comparison to those of 2017 for the following:

- Logan Airport Parking Freeze;
- High occupancy vehicle (HOV) ridership (including Blue Line, Silver Line, scheduled, unscheduled, water transportation, and Logan Express);
- Logan Airport Employee Transportation Management Association (Logan TMA) services;
- Logan Airport gateway volumes;
- On-Airport traffic volumes/vehicle miles traveled (VMT);
- Parking demand and management (including rates and duration statistics);

- Status of proposed ground access planning and the connection to the Massachusetts Bay Transportation Authority (MBTA) Airport Station associated with the planned Terminal E Modernization Project, anticipated MBTA ridership, and possible changes in HOV mode share;
- Status of long-range ground access management strategy planning; and
- Trends of transportation network companies (TNCs), such as Uber and Lyft, and their operations at Logan Airport.

This chapter will also present a discussion of the following topics:

- Impact of TNCs on Logan Airport landside operations;
- Update on parking conditions;
- Massport's cooperation with other transportation agencies to increase transit ridership to and from Logan Airport via the Blue Line and Silver Line;
- Report on Logan Express ridership and efforts to increase capacity and ridership;
- Report on water transportation to and from Logan Airport; and
- Report on results of ongoing ground access studies, as relevant.

Chapter 6. Noise Abatement

This chapter will provide an overview of the environmental regulatory framework affecting aircraft noise, the changes in aircraft noise, and the updates in noise modeling. Massport will use the FAA's Aviation Environmental Design Tool (AEDT) to model 2018 and 2019 noise conditions. The chapter will report on 2018 and 2019 conditions and compare those conditions to those of 2017 for the following:

- Fleet Mix, including various aircraft Stage classifications;
- Nighttime operations;
- Runway utilization (report on aircraft and airline adherence with runway utilization goals); and
- Flight tracks.

This chapter will report on the following:

- Changes in annual noise contours and noise-impacted population;
- Measured versus modeled noise values, including reasons for differences and any improvements attributable to the models deployed;
- Cumulative Noise Index (CNI);

- Times-Above for 65, 75, and 85 "A"-weighted decibel (dBA) threshold values/dwell and persistence of noise levels; and
- Flight track monitoring noise reports.

The chapter will also report on noise abatement efforts, results from the Boston Logan Airport Noise Study (BLANS), and provide a status update on the noise and operations monitoring system. The chapter will report on the status of the RNAV Pilot Project, which will analyze the feasibility of changes to some of RNAV approaches and departures from Logan Airport.

Chapter 7. Air Quality/Emissions Reductions

This chapter will begin with an overview of the environmental regulatory framework affecting aircraft emissions, changes in aircraft emissions, and the changes in air quality modeling. The chapter will provide discussion on progress on the national and international levels to decrease air emissions. The chapter will also discuss analysis methodologies and assumptions and report on 2018/2019 conditions using the FAA's AEDT model. It will compare results in recent EDR/ESPR filings. The Environmental Protection Agency (EPA) required motor vehicle emissions modeling tool (MOtor Vehicle Emission Simulator [MOVES]) will continue to be used to assess vehicular emission on airport roadways. The chapter will include:

- Emissions inventory for carbon monoxide (CO);
- Emissions inventory for oxides of nitrogen (NO_x);
- Emissions inventory for volatile organic compounds (VOCs); and
- Emissions inventory for particulate matter (PM).

This chapter will also report on the following ongoing air quality efforts for 2018/2019:

- Massport's and tenant's alternative fuel vehicle programs; and
- The status of Logan Airport air quality studies undertaken by Massport or others, as available.

This chapter will include Massport's voluntary inventory of greenhouse gas (GHG) emissions from Logan Airport in 2018/2019. GHG emissions will be quantified for aircraft, ground service equipment (GSE), motor vehicles, and stationary sources using emission factors and methodologies outlined in EEA's *Greenhouse Gas Emissions Policy and Protocol*, and the Transportation Research Board's *Guidebook on Preparing Airport Greenhouse Gas Emissions Inventories*[1]. The results of the 2018/2019 GHG emissions inventory will be compared to the 2017 results.

In collaboration with EEA and the Massachusetts Department of Energy Resources (DOER), the *2016 EDR* introduced several new GHG metrics in an effort to more clearly document the effectiveness of the various Massport emission reduction initiatives. These include GHG emissions per passenger, building energy use

1 Airport Cooperative Research Program (ACRP) Report 11, Project 02-06.

intensity, and building GHG emissions. The *2018/2019 EDR* will update the 2017 information and discuss changes, where appropriate.

This chapter will also include an update on Massport's efforts to encourage the use of single engine taxiing under safe conditions. This chapter will also provide an update on the feasibility of combined heat and power (CHP) use for Terminal E and updates to progress made in designing the energy systems for the facility. The *2018/2019 EDR,* like the *2017 ESPR,* will report on the research and regulatory status of Ultrafine Particles (UFPs) and Black Carbon.

Chapter 8. Environmental Compliance and Management/Water Quality

This chapter will report on the 2018 and 2019 status of:

- National Pollutant Discharge Elimination System (NPDES) Permit and monitoring results for Logan Airport's outfalls and the Fire Training Facility;
- Jet fuel usage and spills;
- Massachusetts Contingency Plan (MCP) activities;
- Tank management;
- Update on the environmental management plan; and
- Fuel spill prevention.

The chapter will also present a discussion of the following topics:

- Future stormwater management improvements (if any); and
- Future MCP and tank management activities.

Chapter 9. Project Mitigation Tracking

This chapter will report on the status of mitigation commitments for specific Massport and tenant projects at Logan Airport that have undergone MEPA review and other commitments and have commenced construction. The status of mitigation commitments made in the Section 61 Findings for the following projects will be reported:

- West Garage/Central Garage (EOEA 9790);
- International Gateway (EOEA 9791);
- Logan Airside Improvements Planning Project (EOEA 10458);
- Terminal A Replacement Project (EOEA 12096);
- Southwest Service Area Redevelopment Program/Rental Car Center (EOEA 14137);

- Logan Runway Safety Area Improvements Project (EOEA 14442);
- Terminal E Modernization Project (EEA 15434); and
- Logan Airport Parking Garages Project (EEA 15665).

This chapter will update the status of Massport's mitigation commitments and will also identify projects for which mitigation is complete.

Appendices

MEPA Documentation

These appendices will include a copy of the Secretary's Certificate and comment letters received on the *2017 ESPR*. Individual responses to items raised in the Secretary's Certificate on the *2017 ESPR* and comments in reviewers' letters will be provided. A distribution list for the *2018/2019 EDR* (indicating those receiving documents or CDs) will be provided. The document will also contain copies of any MEPA Certificates or documentation issued for projects at Logan Airport that refer to the EDR/ESPR documentation.

Supporting Technical Documentation

Supporting technical appendices will be provided as necessary.

D

Distribution

This *2017 Environmental Status and Planning Report (ESPR)* has been distributed to federal, state, and city agencies and to parties listed in this appendix. The list includes those entities that the Massachusetts Environmental Policy Act (MEPA) requires as part of the review of the document, representatives of governmental agencies, commenters on the *2016 Environmental Data Report (EDR)*, and community groups concerned with Airport activities. **The 'N' indicates that Massport sent a Notice of Availability and the 'P' indicates that Massport sent a printed copy.**

The *2017 ESPR* is also available on Massport's website at www.massport.com. Limited copies of the *2017 ESPR* may be requested from Michael Gove, Massport, Logan Office Center, One Harborside Drive, Suite 200S, East Boston, MA 02128, telephone (617) 568-3546, email: mgove@massport.com. Printed copies of this report are available for review at the following public libraries:

	Library	Address		Library	Address
P	Boston Public Library Attn. Gail Fithian Main Branch	700 Boylston Street Boston, MA 02116	P	Boston Public Library Charlestown Branch	179 Main Street Charlestown, MA 02129
P	Boston Public Library Connolly Branch	433 Centre Street Jamaica Plain, MA 02130	P	Boston Public Library East Boston Branch	365 Bremen Street East Boston, MA 02128
P	Bedford Public Library	7 Mudge Way Bedford, MA 01730	P	Boston Public Library South Boston Branch	646 East Broadway South Boston, MA 02127
P	Chelsea Public Library	569 Broadway Chelsea, MA 02150	P	Cary Memorial Library	1874 Massachusetts Ave. Lexington, MA 02420
P	Lincoln Public Library	3 Bedford Road Lincoln, MA 01773	P	Concord Public Library	129 Main Street Concord, MA 01742
P	Quincy Public Library Thomas Crane Branch	40 Washington Street Quincy, MA 02169	P	Milton Public Library Main Branch	476 Canton Avenue Milton, MA 02186
P	Winthrop Public Library	2 Metcalf Square Winthrop, MA 02151	P	Revere Public Library	179 Beach Street Revere, MA 02151
P	Medford Public Library	111 High Street Medford, MA 02155	P	State Transportation Library	10 Park Plaza, Suite 4160 Boston, MA 02116
P	Somerville Public Library	79 Highland Avenue Somerville, MA 02143	P	Everett Public Library Parlin Memorial Library	410 Broadway Everett, MA 02149
P	Cambridge Main Library	449 Broadway Cambridge, MA 02138			

Some parties listed below have been provided a hard copy of the document along with a CD of the complete document.

Commenters on the *2016 EDR*

N Cindy L. Christiansen, PhD. 59 Collamore Street Milton, MA 02186	N Paul F. Ormond, P.E. Massachusetts Department of Energy Resources 100 Cambridge St., Suite 1020 Boston, MA 02114	N Milton Board of Selectmen, Town Office Building 525 Canton Avenue Milton, MA 02186
P Astrid Weins, MD, PhD Vice Chair, Winthrop Board of Health 50 Faunbar Avenue Winthrop, MA 02152	P Dawn Quirk & Julia Wallerce Winthrop Airport Hazards Committee 1 Metcalf Square Winthrop, MA 02152	N Peter Houk Medford Representative, Massport CAC 97 Ashcroft Road Medford, MA 02115
N Gail Miller, President Airport Impact Relief, Inc. 395 Maverick Street East Boston, MA 02128	P Nancy S. Timmerman, P.E. Consultant in Acoustics and Noise Control 25 Upton Street Boston, MA 02118	N John Walkey Waterfront Initiative Coordinator, GreenRoots 227 Marginal Street, Suite 1 Chelsea, MA 02150
N Gillian Anderson 810 Saratoga Street East Boston, MA 02128	N James J. Morgan 1025 Hancock Street, Unit 14G Quincy, MA 02169	N Luke Preisner 140 Forest Street Medford, MA 02155

Federal Government

- **United States Senators and Representatives**

P The Honorable Lori Trahan Attn: Emily Byrne U.S. House of Representatives 126 John Street, Suite 12 Lowell, MA 01852	P The Honorable Ayanna Pressley Attn: Erina Colombo U.S. House of Representatives 1700 Dorchester Avenue Boston, MA 02122	P The Honorable Katherine Clark Attn: Wade Blackman U.S. House of Representatives 157 Pleasant Street, Suite 4 Malden, MA 02148
P The Honorable Richard E. Neal U.S. House of Representatives 300 State Street, Suite 200 Springfield MA, 01105	P The Honorable Seth Moulton Attn: Michael Devin U.S. House of Representatives 21 Front Street Salem, MA 01970	P The Honorable William R. Keating Attn: Mike Jackman U.S. House of Representatives 50 Resnik Road, Suite 103 Plymouth, MA 02360
P The Honorable Joseph P. Kennedy III U.S. House of Representatives 29 Crafts Street, Suite 375 Newton, MA 02458	P The Honorable Stephen F. Lynch Attn: Bob Fowkes U.S. House of Representatives One Harbor Street, Suite 304 Boston, MA 02210	P The Honorable James P. McGovern Attn: Kelly Brissett U.S. House of Representatives 12 East Worcester Street, Suite 1 Worcester, MA 01604
P The Honorable Elizabeth Warren 2400 JFK Federal Building 15 New Sudbury Street Boston, MA 02203	P The Honorable Edward J. Markey Attn. Rory Clark 975 JFK Federal Building 15 New Sudbury Street Boston, MA 02203	

Environmental Protection Agency		
P Susan Studlien, Director Office of Environmental Stewardship U.S. Environmental Protection Agency - New England Region 5 Post Office Square – Suite 100 Boston, MA 02109	P Lucy Edmondson Chief of Operations U.S. Environmental Protection Agency - New England Region 5 Post Office Square – Suite 100 Mail Code OEP 06-5 Boston, MA 02109	P Deborah Szaro Acting Administrator U.S. Environmental Protection Agency - New England Region 5 Post Office Square – Suite 100 Mail Code ORA 17-1 Boston, MA 02109
Federal Aviation Administration		
P Colleen D'Alessandro, Acting New England Regional Administrator Department of Transportation FAA - New England Region 1200 District Avenue Burlington, MA 01803	P Brian Brunelle Tower Manager Department of Transportation Federal Aviation Administration Logan International Airport 600 Control Tower, 19th Floor East Boston, MA 02128	P Gail Lattrell Department of Transportation FAA - New England Region Airports Division 1200 District Avenue Burlington, MA 01803
P Lisa Lesperance Department of Transportation FAA - New England Region, Airports Division 1200 District Avenue Burlington, MA 01803	P Richard Doucette Manager, Environmental Programs Department of Transportation FAA - New England Region, Airports Division 1200 District Avenue Burlington, MA 01803	
United States Army Corps of Engineers		
P Colonel William M. Conde Commander and District Engineer U.S. Army Corps of Engineers New England District 696 Virginia Road Concord, MA 01742		
United States Fish and Wildlife Service		
P Wendi Weber Northeast Regional Director U.S. Fish and Wildlife Service Department of the Interior 300 Westgate Center Drive Hadley, MA 01035	P NE Field Office U.S. Fish and Wildlife Service Department of the Interior 70 Commercial St., Suite 300 Concord, NH 03301	
State Government		
Senate/House of Representatives		
P Senate President Karen Spilka Massachusetts State House 24 Beacon Street, Room 332 Boston, MA 02133	P Representative Adrian Madaro, Vice Chair, Joint Committee on Transportation Massachusetts State House, 24 Beacon Street, Room 134 Boston, MA 02133	P Senator Sal DiDomenico Massachusetts State House 24 Beacon Street, Room 208 Boston, MA 02133

■ **Senate/House of Representatives (Continued)**		
P Senator Joseph Boncore, Chair, Joint Committee on Transportation Massachusetts State House 24 Beacon Street, Room 112 Boston, MA 02133	P Speaker of the House, Representative Robert DeLeo Massachusetts State House 24 Beacon Street, Room 356 Boston, MA 02133	P Representative RoseLee Vincent Massachusetts State House 24 Beacon Street, Room 473F Boston, MA 02133
P Representative Daniel Ryan Massachusetts State House, 24 Beacon Street, Room 36 Boston, MA 02133	P Representative William Straus Chair, Joint Committee on Transportation Massachusetts State House 24 Beacon Street, Room 134 Boston, MA 02133	P Senator Nick Collins Massachusetts State House 24 Beacon Street, Room 410 Boston, MA 02133
P Senator Eric Lesser, Vice Chair, Joint Committee on Transportation Massachusetts State House 24 Beacon Street, Room 413C Boston, MA 02133	P Representative David Biele Massachusetts State House 24 Beacon Street, Room 26 Boston, MA 02133	
■ **Executive Office of Energy and Environmental Affairs**		
P Secretary Kathleen Theoharides Executive Office of Energy and Environmental Affairs 100 Cambridge Street, Suite 900 Boston, MA 02114	P Deirdre Buckley, Director Executive Office of Energy and Environmental Affairs 100 Cambridge Street, Suite 900 Boston, MA 02114	P Anne Canaday Environmental Analyst Executive Office of Energy and Environmental Affairs 100 Cambridge Street, Suite 900 Boston, MA 02114
■ **Department of Environmental Protection**		
N Commissioner Martin Suuberg Department of Environmental Protection One Winter Street, 2nd Floor Boston, MA 02108	N MEPA Coordinator MassDEP - Northeast Regional Office 205B Lowell Street Wilmington, MA 01887	N Rachel Freed Section Chief, Wetlands and Waterways MassDEP – Northeast Regional Office 205B Lowell Street Wilmington, MA 01887
N Christine Kirby Director, Air and Climate Division Department of Environmental Protection One Winter Street, 9th Floor Boston, MA 02108	N Jerome Grafe Water Resources, Northeast Region Department of Environmental Protection One Winter Street, 10th Floor Boston, MA 02108	
■ **Department of Public Health**		
N Monica Bharel, MD, MPH Commissioner, Department of Public Health Department of Public Health 250 Washington Street Boston, MA 02108	N Margaret Round Environmental Analyst Bureau of Environmental Health 250 Washington Street, 7th Floor Boston, MA 02108	

- **Department of Conservation and Recreation**

N Commissioner Leo Roy
Department of Conservation and Recreation
251 Causeway Street, Suite 600
Boston, MA 02114

- **Metropolitan Area Planning Council**

N Marc Draisen, Executive Director
Metropolitan Area Planning Council
60 Temple Place, 6th Floor
Boston, MA 02111

N Eric Bourassa, Transportation Director
60 Temple Place, 6th Floor
Boston, MA 02111

- **Department of Fisheries, Wildlife and Environmental Law Enforcement**

N Environmental Reviewer
Mass Wildlife
Field Headquarters
1 Rabbit Hill Road
Westborough, MA 01581

- **Department of Housing and Community Development**

N Janelle Chan, Undersecretary
Department of Housing and Community Development
100 Cambridge Street #300
Boston, MA 02114

- **Coastal Zone Management**

N Lisa Berry Engler, Director
Office of Coastal Zone Management
251 Causeway Street, Suite 800
Boston, MA 02114

- **Central Transportation Planning Staff**

N Scott Peterson
Interim Co-Executive Director
Central Transportation Planning Staff
10 Park Plaza, Room 2150
Boston, MA 02116

N Annette Demchur
Interim Co-Executive Director
Central Transportation Planning Staff
10 Park Plaza, Room 2150
Boston, MA 02116

- **Massachusetts Water Resources Authority**

N Frederick A. Laskey
Executive Director, Massachusetts Water Resources Authority
Charlestown Navy Yard
100 First Avenue, Building 39
Charlestown, MA 02129

N Katie Ronan
Environmental Analyst
Water Resources Authority
Charlestown Navy Yard
100 First Avenue, Building 39
Charlestown, MA 02129

- **Massachusetts Department of Transportation (MassDOT)**

N Stephanie Pollack
Secretary of Transportation, CEO
MassDOT
10 Park Plaza, Suite 4160
Boston, MA 02116

N Katherine Fichter
Assistant Secretary for Policy Coordination
MassDOT Highway
10 Park Plaza, Suite 3510
Boston, MA 02116

N Jonathan Gulliver
Administrator, Highway Division
MassDOT
10 Park Plaza, Suite 7410
Boston, MA 02116

N Jeffrey DeCarlo
Administrator, Aeronautics Division
MassDOT
Logan Office Center
One Harborside Drive, Suite 205N
East Boston, MA 02128

N David Mohler
Executive Director, Office of Transportation Planning
MassDOT
10 Park Plaza, Suite 4150
Boston, MA 02116

N Andrew Brennan
Director of Environmental Affairs
MBTA
10 Park Plaza, Suite 6720
Boston, MA 02116

■ **Massachusetts Department of Transportation (MassDOT) (Continued)**		
N Rick McCullough Director of Environmental Engineering, MassDOT 185 Kneeland Street, 9th floor Boston, MA 02111	N David J. White, Acting Director of Environmental Services, Highway Division MassDOT 10 Park Plaza, Suite 4260 Boston, MA 02116	N Steve Poftak MBTA General Manager 10 Park Plaza, Suite Boston, MA 02116
N David Panagore, Chief Administrative Officer, MBTA 10 Park Plaza, Suite 3910 Boston, MA 02116		
■ **Massachusetts Historical Commission**	■ **Massachusetts Executive Office of Health and Human Services**	■ **Massachusetts Department of Public Safety**
N William Francis Galvin Secretary of the Commonwealth 220 Morrissey Boulevard Boston, MA 02125	N Secretary Marylou Sudders, Executive Office of Health and Human Services One Ashburton Place, 11th Floor Boston, MA 02108	N Secretary Thomas Turco Department of Public Safety 1000 Washington Street Boston, MA 02118
■ **Natural Heritage and Endangered Species Program**		
N Lauren Glorioso, Endangered Species Review Biologist Natural Heritage and Endangered Species Program 1 Rabbit Hill Road Westboro, MA 01581		
■ **Massachusetts Port Authority Board of Directors**		
P Lewis G. Evangelidis, Chair Massport Board of Directors Massachusetts Port Authority One Harborside Drive East Boston, MA 02128	P Stephanie Pollack Massport Board of Directors Massachusetts Port Authority One Harborside Drive East Boston, MA 02128	P Laura Sen Massport Board of Directors Massachusetts Port Authority One Harborside Drive East Boston, MA 02128
P Patricia Jacobs Massport Board of Directors Massachusetts Port Authority One Harborside Drive East Boston, MA 02128	P John Nucci Massport Board of Directors Massachusetts Port Authority One Harborside Drive East Boston, MA 02128	P Sean M. O'Brien Massport Board of Directors Massachusetts Port Authority One Harborside Drive East Boston, MA 02128
P Warren Fields Massport Board of Directors Massachusetts Port Authority One Harborside Drive East Boston, MA 02128		

Municipalities

- **City of Boston**

Office of the Mayor	**Boston Transportation Department**	
P Martin J. Walsh, Mayor City of Boston One City Hall Square Boston, MA 02201	P Gregory Rooney, Acting Commissioner Boston Transportation Department One City Hall Square, Room 721 Boston, MA 02201	P Robert D'Amico, City Planner Boston Transportation Department One City Hall Square, Room 721 Boston, MA 02201
Boston Planning & Development Agency	**Civic Engagement and Neighborhood Services**	
P Brian Golden, Director Boston Planning & Development Agency One City Hall Square, 9th floor Boston, MA 02201	P Jerome Smith, Chief of Civic Engagement and Director of the Mayor's Office of Neighborhood Services One City Hall Square, Room 805 Boston, MA 02201	N Lina Tramelli City of Boston One City Hall Square, Room 805 Boston, MA 02201
Boston Parks and Recreation Department	**City Clerk's Office**	**Boston Public Health Commission**
P Ryan Woods, Commissioner Parks and Recreation Department 1010 Massachusetts Avenue, 3rd Floor Boston, MA 02118	P Maureen Feeney City Clerk One City Hall Square, Room 601 Boston, MA 02201	P Monica Valdez Lupi, JD, MPH Executive Director Boston Public Health Commission 1010 Massachusetts Avenue, 2nd Floor Boston, MA 02118
Office of Environment, Energy, and Open Space		
N Christopher Cook, Chief Office of Environment, Energy, and Open Space One City Hall Square, Room 709 Boston, MA 02201		
Boston Environment Department		
P Carl Spector, Commissioner Environment Department One City Hall Square, Room 709 Boston, MA 02201	P Alison Brizius, Director of Climate and Environmental Planning Environment Department One City Hall Square, Room 709 Boston, MA 02201	P Maura Zlody Environment Department One City Hall Square, Room 709 Boston, MA 02201
Boston Water and Sewer Commission		
N John Sullivan, Chief Engineer Boston Water and Sewer Commission 980 Harrison Avenue Boston, MA 02119	N Adam Horst Project Director Boston Water and Sewer Commission 980 Harrison Avenue Boston, MA 02119	N Charlie Jewell Director of Planning Boston Water and Sewer Commission 980 Harrison Avenue Boston, MA 02119

■ **Boston City Council**		
N Michelle Wu Councilor-At-Large One City Hall Square, Suite 550 Boston, MA 02201	N Michael Flaherty Councilor-At-Large One City Hall Square, Suite 550 Boston, MA 02201	N Althea Garrison Councilor-At-Large One City Hall Square, Suite 550 Boston, MA 02201
N Annissa Essaibi George Councilor-At-Large One City Hall Square, Suite 550 Boston, MA 02201	N Lydia Edwards, Councilor, District 1 Attn. Gabriela Coletta One City Hall Square, Suite 550 Boston, MA 02201	N Ed Flynn, Councilor, District 2 One City Hall Square, Suite 550 Boston, MA 02201
N Frank Baker, Councilor, District 3 One City Hall Square, Suite 550 Boston, MA 02201	N Andrea Campbell, City Council President & Councilor, District 4 One City Hall Square, Suite 550 Boston, MA 02201	N Timothy McCarthy, Councilor, District 5 One City Hall Square, Suite 550 Boston, MA 02201
N Matt O'Malley, Councilor, District 6 One City Hall Square, Suite 550 Boston, MA 02201	N Kim Janey, Councilor, District 7 One City Hall Square, Suite 550 Boston, MA 02201	N Josh Zakim, Councilor, District 8 One City Hall Square, Suite 550 Boston, MA 02201
N Mark Ciommo, Councilor, District 9 One City Hall Square, Suite 550 Boston, MA 02201		
■ **Town of Milton**		
N Milton Board of Selectmen Town Office Building 525 Canton Avenue Milton, MA 02186	N Michael Dennehy Town Administrator Town Office Building 525 Canton Avenue Milton, MA 02186	
■ **City of Chelsea**		
N Thomas G. Ambrosino, City Manager Chelsea City Hall 500 Broadway Chelsea, MA 02150	N Jeannette Cintron White, City Clerk Chelsea City Hall 500 Broadway Chelsea, MA 02150	N Roy Avellaneda Councillor-At-Large Chelsea City Hall 500 Broadway Chelsea, MA 02150
N Stephen Sarikas Chelsea Conservation Commission Chelsea City Hall 500 Broadway Chelsea, MA 02150	N Luis Prado, MSPIH, Director Board of Health & Human Services Chelsea City hall 500 Broadway Chelsea, MA 02150	N John DePriest Director of Planning & Development City of Chelsea 500 Broadway, Room 101 Chelsea, MA 02150
■ **City of Quincy**		
N Thomas Koch, Mayor Quincy City Hall 1305 Hancock Street Quincy, MA 02169	N Brad L. Croall, Council President Quincy City Council 92 Viden Road Quincy, MA 02169	N Nicole L. Crispo, City Clerk Quincy City Hall 1305 Hancock Street Quincy, MA 02169
N Kristen L. Hughes, Councillor Ward 5, Quincy City Council 116 Willow Avenue Quincy, MA 02170	N Brian Palmucci, Councillor Ward 4 Quincy City Council 1305 Hancock Street Quincy, MA 02169	

■	**City of Revere**				
N	Brian Arrigo, Mayor Revere City Hall 281 Broadway Revere, MA 02151	N	Ashley Melnik, City Clerk Revere City Hall 281 Broadway Revere, MA 02151		
■	**Town of Winthrop**				
N	Austin Faison, Town Manager Winthrop Town Hall One Metcalf Square Winthrop, MA 02152	N	David Stasio, Chairman Winthrop Planning Board Winthrop Town Hall One Metcalf Square Winthrop, MA 02152	N	Norman P. Hyett, Chair, Winthrop Conservation Commission Winthrop Public Facilities Building 100 Kennedy Drive Winthrop, MA 02152
N	Ronald Vecchia Council President Winthrop Town Hall One Metcalf Square Winthrop, MA 02152	N	Philip Boncore, Esq. Vice President, Councilor-At-Large Winthrop Town Hall One Metcalf Square Winthrop, MA 02152	N	Mike Lucerto Councilor-At-Large Winthrop Town Hall One Metcalf Square Winthrop, MA 02152
N	Richard Ferrino Councilor, Precinct 1 Winthrop Town Hall One Metcalf Square Winthrop, MA 02152	N	James Letterie, Councilor, Precinct 2 Winthrop Town Hall One Metcalf Square Winthrop, MA 02152	N	Nicholas LoConte Councilor, Precinct 3 Winthrop Town Hall One Metcalf Square Winthrop, MA 02152
N	Heather Engman, Esq. Councilor, Precinct 4 Winthrop Town Hall One Metcalf Square Winthrop, MA 02152	N	Peter Christopher Councilor, Precinct 5 Winthrop Town Hall One Metcalf Square Winthrop, MA 02152	N	Linda J. Calla Councilor, Precinct 6 Winthrop Town Hall One Metcalf Square Winthrop, MA 02152
N	Richard Bangs Airport Hazards Committee One Metcalf Square Winthrop, MA 02152	P	Dawn Quirk, Secretary, Airport Hazards Committee 11 Hale Ave Winthrop, MA 02152	P	Astrid Weins, MD, PhD, Vice Chair Winthrop Board of Health One Metcalf Square Winthrop, MA 02152
N	Bill Schmidt, Chair Winthrop Board of Health One Metcalf Square Winthrop, MA 02152	P	Gina Cassetta Airport Hazards Committee 9 Whittier Ave Winthrop, MA 02152		
■	**Town of Bedford**				
N	Margot R. Fleischman, Chair Board of Selectmen Town of Bedford 10 Mudge Way Bedford, MA 01730	N	Sarah Stanton, Town Manager Town of Bedford 10 Mudge Way Bedford, MA 01730	N	Hanscom Field Advisory Commission Representative Town of Bedford 10 Mudge Way Bedford, MA 01730
■	**Town of Lexington**				
N	Douglas M. Lucente, Chair, Board of Selectmen & Hanscom Area Towns Committee Chair Lexington Town Office Building, 1625 Massachusetts Avenue Lexington, MA 02420	N	James J. Malloy Town Manager Lexington Town Hall 1625 Massachusetts Avenue Lexington, MA 02173	N	Hanscom Field Advisory Commission Representative Town of Lexington 1625 Massachusetts Avenue Lexington, MA 02173

■ Town of Concord		
N Michael Lawson Chair, Board of Selectman PO Box 535 Concord, MA 01742	N Christopher Whelan Town Manager Town of Concord PO Box 535 Concord, MA 01742	N Hanscom Field Advisory Commission Representative Town of Concord PO Box 535 Concord, MA 01742
■ Town of Lincoln		
N Timothy S. Higgins Town Administrator Lincoln Town Office 16 Lincoln Road Lincoln, MA 01773	N Jennifer Glass Chair, Board of Selectmen Lincoln Town Office 16 Lincoln Road Lincoln, MA 01773	
■ City of Everett		
N Carlo DeMaria, Mayor Everett City Hall 484 Broadway Everett, MA 02149	N Michael O'Connor Chair, Planning Board Everett City Hall 484 Broadway Everett, MA 02149	N Tony M. Sousa, AICP Deputy Director, Planning & Development Everett City Hall 484 Broadway, Room 25 Everett, MA 02149
■ City of Medford		
N Stephanie M. Burke, Mayor Medford City Hall 85 George Hassett Drive, Rm 202 Medford, MA 02155	N John DePriest, Chair Community Development Board Medford City Hall 85 George Hassett Drive Medford, MA 02155	N Lauren DiLorenzo Director, Office of Community Development 85 George Hassett Drive, Rm 308 Medford, MA 02155
Community Groups and Interested Parties		
■ Massport Community Advisory Committee (CAC)		
N Matthew Romero, Executive Director Massport CAC P.O. Box 470614 Brookline, MA 02447		
■ Charlestown Neighborhood Council		
N Tom Cunha, Chairman Charlestown Neighborhood Council 427 Bunker Hill Street Charlestown, MA 02129	N Peggy Bradley, First Vice Chairman Charlestown Neighborhood Council 23 Ferrin Street Charlestown, MA 02129	
■ Chelsea Community		
N Maureen Foley, President Chelsea Rotary PO Box 505647 Chelsea, MA 02150-5647	N Rosalba Medina, President Chelsea Collaborative 318 Broadway Chelsea, MA 02150	N Joseph W. Mahoney, President Chelsea Chamber of Commerce 308 Broadway Chelsea, MA 02150
N Leo Robinson, Councillor At-Large Chelsea City Council 83 Warren Avenue Chelsea, MA 02150		

■ Jamaica Plain Community		
N Nancy Brooks and Maura Meagher 92 Bourne St Jamaica Plain, MA 02130	N Marvin Kabakott 98 Bourne St Jamaica Plain, MA 02130	N Martha Merson 19 Roseway St Jamaica Plain, MA 02130
N Susan Morony 33 Bournedale Rd Jamaica Plain, MA 02130		
■ East Boston Community		
N Michelle Moon, Greenway Coordinator Friends of the East Boston Greenway (Notice of Availability provided electronically)	N Jesse Purvis, Vice President Greenway Council 551 Summer Street, #2 East Boston, MA 02128	N David Arinella 20 Thurston Street East Boston, MA 02128
N Max Gruner, Executive Director East Boston Main Streets 146 Maverick Street East Boston, MA 02128	P Patricia D'Amore 95 Webster Street East Boston, MA 02128	N April Abenza 150 Orleans Street, #607 East Boston, MA02128
N Commodore Jeffries Yacht Club 565 Sumner Street East Boston, MA 02128	N Fran Carbone 174 Bayswater Street East Boston, MA 02128	N Justin Pasquariello, Executive Director East Boston Social Centers 68 Central Square East Boston, MA 02128
N Matt Barison Harborview Community Association 124 Coleridge Street East Boston, MA 02128	N Robert Strelitz, President Piers PAC 14 Archer Avenue Revere, MA 02151	N Matthew Small 156 Porter Street Condo Association 156 Porter Street East Boston, MA 02128
N Gloribell Mota, Lead Organizer Neighbors United for a Better East Boston (NUBE) 19 Meridian Street, #4 East Boston, MA 02128	N Joseph Ruggiero, Jr. Orient Heights Neighborhood Association 683 Bennington Street East Boston, MA 02128	N Debra Cave, President Eagle Hill Civic Association 106 White Street East Boston, MA 02128
N Cindy Baxter, Co-Chair Jeffries Point Neighborhood Association 539A Sumner Street East Boston, MA 02128	N Mary Cole, Vice Chair Jefferies Point Neighborhood Association 241 Webster Street East Boston, MA 02128	N Joanne Pomodoro 683 Bennington Street East Boston, MA 02128
N Gail Miller, President Airport Impact Relief Inc. 232 Orient Avenue East Boston, MA 02128	N Christopher Marchi Airport Impact Relief Inc. 161 Saratoga Street East Boston, MA 02128	N James Kearney, President East Boston Chamber of Commerce 175 McClellan Highway, Suite 1 East Boston, MA 02128
N Michael Triant, Executive Director Salesian Boys & Girls Club 150 Byron Street East Boston, MA 02128	N Jack Scalione Gove Street Neighborhood Association 36 Frankfurt Street East Boston, MA 02128	N Joseph Gaeta, Executive Director East Boston YMCA 215 Bremen Street East Boston, MA 02128

East Boston Community (Continued)		
N Commodore Orient Heights Yacht Club 61 Bayswater Street East Boston, MA 02128	N Fran Riley 193 Trenton Street East Boston, MA 02128	N Anna DiMaria, Esq. 23 Meridian Street East Boston, MA 02128
N Karen Buttiglieri 56 Beachview Road East Boston, MA 02128	N Mary Berninger 156 St. Andrew Road East Boston, MA 02128	
South Boston Community		
N Joanne McDevitt City Point Neighborhood Association 787 East Broadway South Boston, MA 02127	N Hailey Dillon Mayor's Office of Neighborhood Services 1 City Hall Plaza Boston, MA 02201	N Lucky Devlin 718 East Second Street South Boston, MA 02127
N Mr. William Spain President Castle Island Association PO Box 342 South Boston, MA 02127	N Seaport Alliance for a Neighborhood Design 300 Summer Street Boston, MA 02210	N Joe Rogers Fort Point Neighborhood Association 21 Wormwood Street South Boston, MA 02127
N Ellie Kasper St. Vincent's Neighborhood Association 125 West Third Street South Boston, MA 02127		
Winthrop Community		
N Paul Leavy, President Winthrop Chamber of Commerce 207 Hagman Road Winthrop, MA 02152	N Betsy Shane, Executive Director Winthrop Chamber of Commerce 207 Hagman Road Winthrop, MA 02152	N Mary Mitchell, President Friends of Belle Isle Marsh P.O. Box 575 East Boston, MA 02128
N Robert Pulsifer 1050 Shirley Street Winthrop, MA 02152	N Vin Recchia, Vice President Winthrop Chamber of Commerce 207 Hagman Road Winthrop, MA 02152	N John Vitagliano 19 Seymour Street Winthrop, MA 02152
Organizations and Other Interested Parties		
N John E. Drew President, Drew Company, Inc. 2 Seaport Lane, Floor 9 Boston, MA 02210	N James T. Brett President and Chief Executive Officer The New England Council 98 North Washington Street, Suite 201 Boston, MA 02114	N Adam Mitchell Save That Stuff Inc. 100 Terminal Street Charlestown, MA, 02129
N Dr. Bruce A. Egan, President, Egan Environmental, Inc. 75 Lothrop Street Beverly, MA 01915	N K. Dun Gifford, President Comm. for Regional Transportation 15 Hilliard Street Cambridge, MA 02138	N Bradley Campbell, President Conservation Law Foundation 62 Summer Street Boston, MA 02116

■ **Organizations and Other Interested Parties (Continued)**

N Stephen Schultz Engel & Schultz, LLP One Federal Street, Suite 2120 Boston, MA 02110	N Kathy Abbott, President and CEO Boston Harbor Now 15 State Street #1100 Boston, MA 02109	N Wig Zamore 13 Highland Avenue, #3 Somerville, MA 02143
N Ben Pignatelli, Chair Sierra Club – MA Chapter 50 Federal Street, 3rd Floor Boston MA 02110	N Daniel McCormack R. S., C.H.O. Director of Public Health Weymouth Town Hall 75 Middle Street Weymouth, MA 02189	N Mystic View Task Force PO Box 441979 Somerville, MA 02144
N Patrick Herron, Executive Director Mystic River Watershed Association 20 Academy Street, Suite 306 Arlington, MA 02476	N Francis X. Callahan, Jr., President Boston Metropolitan District Building Trades Council 35 Highland Avenue Malden, MA 02148	N Gary Clayton, President Massachusetts Audubon Society 208 South Great Road Lincoln, MA 01773
N Darrin McAuliffe Manager-Secretary, Rider Oversight Committee 45 High Street Boston, MA 02110	N MAPC - MetroFuture Steering Committee 60 Temple Place Boston, MA 02111	N Somerville Transportation Equity Partnership 51 Mt. Vernon St. Somerville, MA 02145
N Tani Marinovich, President Save the Harbor/Save the Bay Boston Fish Pier 212 Northern Avenue, Suite 304 West Boston, MA 02210	N Jesse Spence, Vice President Noise Control Engineering 85 Rangeway Road, Building 2 Floor 2 Billerica, MA 01862	N Dorothy McGlincy, Executive Director Massachusetts Association of Conservation Commissions 10 Juniper Road Belmont, MA 02478
N Kristen O'Brien 45 Badger Circle Milton, MA 02186	N Darryl Pomicter 136 Myrtle Street Boston, MA 02114	N Stephen H. Kaiser, PhD. 191 Hamilton Street Cambridge, MA 02139
N Aaron M. Toffler, Esq. Airport Impact Relief, Inc. 34 Kimball Street Needham, MA 02492	N John Antonellis 93 Lexington Street East Boston, MA 02128	N James Roberts 59 Magazine Street Cambridge, MA 02139
N James Linthwaite 155 Cowper Street East Boston, MA 02128		

■ **Massport Business Group**

N Chris Anderson Massachusetts High Technology Council Reservoir Woods 850 Winter Street Waltham, MA 02451	N James Brett, President & CEO New England Council 98 North Washington Street, No. 201 Boston, MA 02114	N J.D. Chesloff, Executive Director Massachusetts Business Roundtable 141 Tremont Street Boston, MA 02111
N Bob Coughlin Massachusetts Biotech Council 300 Technology Square, 8th Floor Cambridge, MA 02139	N Rick Dimino A Better City 33 Broad Street, #300 Boston, MA 02109	N Rich Doherty, President Association of Independent Colleges and Universities 11 Beacon Street, Suite 1224 Boston, MA 02108

- **Massport Business Group (Continued)**

N Alan Fein Kendall Square Association 510 Kendall Street Cambridge, MA 02142	N Peter Forman, President & CEO South Shore Chamber of Commerce 1050 Hingham Street Rockland, MA 02370	N Abbie Goodman ACEC MA The Engineering Center Education Trust One Walnut Street Boston, MA 02108
N Pamela Goldberg Mass Technology Collaborative 2 Center Plaza Boston, MA 02108	N Bill Guenther Mass Insight 18 Tremont Street, #1010 Boston, MA 02108	N Susan Houston MassEcon 101 Walnut Street Watertown, MA 02108
N Eileen McAnneny Massachusetts Taxpayers Foundation 24 Province Street Boston, MA 02108	N Jesse Mermell Alliance of Business Leadership 21 Drydock Avenue, 6th Floor c/o MassChallenge Boston, MA 02210	N Josh Ostroff Transportation for Massachusetts 50 Milk Street, 16th Floor Boston, MA 02109
N Jim Rooney Boston Chamber of Commerce 265 Franklin Street, #1200 Boston, MA 02110	N Jody Rose New England Venture Capital Association One Broadway, 14th Floor Cambridge, MA 02142	N Kristen Rupert Associated Industries of Massachusetts 1 Beacon Street Boston, MA 02108
N Betsy Shane Winthrop Chamber of Commerce 207 Hagman Road Winthrop, MA 02152	N Tom Sommer MassMedic 650 Albany Street, Suite 105 Boston, MA 02118	N Monica Tibbits-Nutt 128 Business Council 395 Totten Pond Road Waltham, MA 02451
N Greg Torres MassINC 11 Beacon Street, Suite 500 Boston, MA 02108	N Greater Boston Visitors and Convention Bureau 2 Copley Place, #105 Boston, MA 02116	

Technical Appendices

- Appendix E, Activity Levels
- Appendix F, Regional Transportation
- Appendix G, Ground Access to and from Logan Airport
- Appendix H, Noise Abatement
- Appendix I, Air Quality/Emissions Reduction
- Appendix J, Environmental Compliance and Management/Water Quality
- Appendix K, Peak Period Pricing Monitoring Reports
- Appendix L, Reduced/Single Engine Taxiing at Logan Airport Memoranda

This Page Intentionally Left Blank.

E

Activity Levels

This appendix provides detailed tables in support of Chapter 2, *Activity Levels*:

- Table E-1 Logan Airport Historical Air Passenger and Operations Data
- Table E-2 Logan Airport Changes in Domestic Passenger Operations by Carrier
- Table E-3 Logan Airport Changes in International Passenger Operations by Carrier
- Table E-4 Logan Airport Scheduled Passenger Departures by Destination

Logan Airport Forecast Methodology and Assumptions

- Table E-5 Actual and Forecast Logan Airport Passengers, Cargo, and Aircraft Operations, 2017 and Future Planning Horizon
- Table E-6 Passenger Forecast Assumptions
- Table E-7 Actual and Forecast Logan Airport Passengers, 2017 and Future Planning Horizon
- Table E-8 Average Load Factors and Average Aircraft Size, 2017 and Future Planning Horizon
- Table E-9 Actual and Forecast Logan Airport Operations, 2017 and Future Planning Horizon
- Table E-10 Actual and Forecast Logan Airport Express/Freight (in pounds), 2017 and Future Planning Horizon
- Table E-11 Scheduled Passenger Airline Operations by Aircraft Category, Actual 2017 and Future Planning Horizon
- Table E-12 Cargo Airline Operations by Aircraft Category, Actual 2017 and Future Planning Horizon
- Table E-13 Forecast Logan Airport Operations by Aircraft Type, Actual 2017 and Future Planning Horizon
- Table E-14 Stage Length Assumptions, North American Scheduled Passenger Airline Operations, Future Planning Horizon
- Table E-15 Stage Length Assumptions, Long-Haul International Scheduled Passenger Airline Operations, Future Planning Horizon

Table E-1 Logan Airport Historical Air Passenger and Operations Data

Year	Operations	Air Passengers	Year	Operations	Air Passengers
1980	258,167	14,722,363	1999	494,816	27,052,078
1981	251,961	14,827,684	2000	487,996	27,726,833
1982	244,468	15,867,722	2001	463,125	24,474,930
1983	288,956	17,848,797	2002	392,079	22,696,141
1984	318,959	19,417,971	2003	373,304	22,791,169
1985	349,518	20,448,424	2004	405,258	26,142,516
1986	363,995	21,862,718	2005	409,066	27,087,905
1987	414,968	23,369,002	2006	406,119	27,725,443
1988	407,479	23,732,959	2007	399,537	28,102,455
1989	388,797	22,272,860	2008	371,604	26,102,651
1990	424,568	22,878,191	2009	345,306	25,512,086
1991	430,403	21,450,143	2010	352,643	27,428,962
1992	474,378	22,723,138	2011	368,987	28,907,938
1993	493,093	23,579,726	2012	354,869	29,235,643
1994	458,623	24,468,178	2013	361,339	30,218,631
1995	466,327	24,192,095	2014	363,797	31,634,445
1996	456,226	25,134,826	2015	372,930	33,449,580
1997	482,542	25,567,888	2016	391,222	36,288,042
1998	507,449	26,526,708	**2017**	**401,371**	**38,412,419**

Source: Massport and U.S. Department of Transportation, T-100 Database

Table E-2 Logan Airport Changes in Domestic Passenger Operations by Carrier

Airline	**2000**	**2005**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2016-2017 Change**	**2016-2017 Percent Change**
Scheduled Jet Carriers	**233,993**	**190,991**	**203,052**	**207,369**	**203,376**	**211,176**	**214,854**	**225,629**	**235,381**	**242,404**	**7,023**	**3.0%**
AirTran Airlines	3,090	14,580	13,672	12,869								
Alaska Airlines		1,088	1,733	1,757	1,873	2,661	3,090	3,027	3,256	3,351	95	2.9%
America West Airlines	5,116	4,467										
American Airlines[1]	30,821	27,712	21,313	18,943	20,962	22,535	58,222	56,623	55,249	50,766	-4,483	-8.1%
American Trans Air	1,448	2,294										
Continental Airlines	16,894	13,546	10,869									
Delta Air Lines[2]	52,954	36,388	28,980	25,429	23,270	21,139	23,614	30,705	30,476	32,050	1,574	5.2%
Frontier Airlines	1,052		1,094		275					2	2	
Independence Air		4,676										
JetBlue		15,069	49,981	58,737	63,210	73,374	76,247	79,364	84,590	93,485	8,895	10.5%
Midway Airlines	4,096											
Midwest Airlines	3,726	3,570	1,961	2,786								
Northwest Airlines	13,147	9,685										
People Express							170					
Southwest Airlines[3]			13,727	17,413	23,667	23,701	21,967	21,542	24,436	24,129	-307	-1.3%
Spirit Airlines			3,023	3,054	3,365	2,721	2,945	4,896	7,245	8,853	1,608	22.2%
Sun Country Airlines	723		313	509	596	926	1,027	1,414	1,374	1,391	17	1.2%
Trans World Airlines	6,280											
United Airlines[4]	28,092	18,304	16,314	26,425	25,636	25,214	24,374	24,632	25,031	24,623	-408	-1.6%
US Airways[5]	66,554	39,612	36,678	36,421	36,633	35,613						
Virgin America			3,394	3,026	3,889	3,292	3,198	3,426	3,724	3,754	30	0.8%
Regional/Commuter Carriers	**160,041**	**137,203**	**94,535**	**89,586**	**79,790**	**79,922**	**76,682**	**70,274**	**68,204**	**68,753**	**549**	**0.8%**
America West Express	1,267											
American Eagle	62,140	37,394	15,291	6,669	4	4	5	52	6,418	7,046	628	9.8%
Cape Air	31,026	25,018	35,899	35,940	37,184	37,194	35,080	35,994	35,993	33,235	-2,758	-7.7%
Continental Connection			1,809	1,199	131							
Continental Express		12,544	529	902	385							
Delta Connection	15,438	26,557	18,445	23,243	20,925	20,848	20,265	15,466	18,586	22,231	3,645	19.6%
MidAtlantic Express												
Midwest/Republic			258									
Northwest Airlink		5,034										
PenAir					2,268	4,384	4,382	3,747	3,662	3,438	-224	-6.1%
Republic Airlines						58	53	34				
United Express		3,178	2,802	2,763	4,342	5,829	5,628	4,699	3,545	2,803	-742	-20.9%
US Airways Express	50,170	27,478	19,502	18,870	14,551	11,605	11,269	10,282				
Non-Scheduled Operations (Incl. Charter)	**1,008**	**325**	**501**	**106**	**181**	**200**	**164**	**176**	**158**	**176**	**18**	**11.4%**
Total Domestic Operations	**395,042**	**328,519**	**298,117**	**297,061**	**283,347**	**291,298**	**291,700**	**296,079**	**303,743**	**311,333**	**7,590**	**2.5%**

Source: Massport

Notes: Excludes general aviation and all-cargo operations.

1 American Airlines includes US Airways beginning in 2014 (following 2013 merger).

2 Delta Air Lines totals include Northwest Airlines beginning in 2009 (following 2008 merger).

3 Southwest Airlines include AirTran Airways beginning 2012 (following 2011 merger).

4 United Airlines totals include Continental Airlines beginning in 2011 (following 2010 merger).

5 US Airways totals in this chart include America West Airlines beginning in 2006 (following 2005 merger).

Table E-3 Logan Airport Changes in International Passenger Operations by Carrier

Airline	2000	2005	2010	2011	2012	2013	2014	2015	2016	2017	2016-2017 Change	2016-2017 Percent Change
Scheduled Jet Carriers	**27,427**	**24,550**	**20,771**	**24,973**	**25,633**	**23,301**	**25,065**	**28,225**	**34,752**	**37,522**	**2,770**	**8.0%**
Aer Lingus	1,160	1,016	1,097	1,130	1,273	1,513	1,933	1,973	2,066	2,011	-55	-2.7%
Aeromexico		534						345	580	624	44	7.6%
Air Berlin									192	278	86	44.8%
Air Canada	10,047	5,782	3,895	4,125	4,517	1,747	1,084	1,686	2,729	3,982	1,253	45.9%
Air Europa										72	72	
Air France	1,046	1,334	995	1,013	974	955	899	910	900	884	-16	-1.8%
Air Jamaica		349										
Air One												
Alitalia	729	986	624	604	530	542	550	562	558	548	-10	-1.8%
American Airlines[1]	4,657	4,672	2,422	2,149	1,901	447	344	571	533	530	-3	-0.6%
Astraeus				100								
Avianca										226	226	
British Airways	2,159	2,151	2,082	2,161	2,149	2,573	2,678	2,575	2,702	2,522	-180	-6.7%
Canadian Airlines	417											
Cathay Pacific								279	454	652	198	43.6%
Copa Airlines						347	730	646	638	730	92	14.4%
Delta Air Lines[2]	733	749	1,675	3,280	2,531	2,851	3,008	3,122	3,459	3,871	412	11.9%
El Al								152	296	298	2	0.7%
Emirates							600	914	1,382	1,034	-348	-25.2%
Eurowings									72		-72	-100.0%
Finnair		44										
FlyGlobespan												
Hainan Airlines							280	744	961	1,032	71	7.4%
Iberia Airlines			435	445	441	404	332	336	412	464	52	12.6%
Icelandair	726	811	816	928	938	1,120	1,227	1,287	1,338	1,265	-73	-5.5%
Japan Airlines					474	646	731	728	736	730	-6	-0.8%
JetBlue			2,262	5,173	5,902	6,138	6,348	6,488	7,146	7,406	260	3.6%
KLM Royal Dutch Airlines										2	2	
Korean Air Lines	314											
LACSA Airlines												
Lufthansa	1,140	1,564	1,657	1,734	1,784	1,723	1,712	1,687	1,728	1,707	-21	-1.2%
Northwest Airlines	744	727										
Norwegian Air Shuttle								34	656	718	62	9.5%
Olympic Airways	256											
Qatar Airways									552	728	176	31.9%
Sabena	724											
SATA International Airlines		315	403	400	412	466	533	542	630	844	214	34.0%
Scandinavian Airlines									500	536	36	7.2%
SWISS International	926	704	720	725	716	720	722	711	1,020	924	-96	-9.4%
TACA		327										
TACV - Cabo Verde		154	240	236	234	214	186	60				

Table E-3 Logan Airport Changes in International Passenger Operations by Carrier (Continued)

Airline	2000	2005	2010	2011	2012	2013	2014	2015	2016	2017	2016-2017 Change	2016-2017 Percent Change
TAP - Air Portugal	200								378	643	265	70.1%
Thomas Cook Airlines									62	144	82	132.3%
Trans World Airlines												
Turkish Airlines							452	726	658	616	-42	-6.4%
United Airlines	728								21	13	-8	-38.1%
US Airways		1,607	667	49	146	186						
VG Airlines												
Virgin Atlantic Airways	721	724	707	721	711	709	716	702	715	764	49	6.9%
Wow Air								445	678	724	46	6.8%
Regional/Commuter Carriers	**15,594**	**13,112**	**12,494**	**12,153**	**12,270**	**14,378**	**14,720**	**14,153**	**15,204**	**14,597**	**-607**	**-4.0%**
Air Canada Regional	4,088	5,120	7,065	6,803	7,058	9,563	10,364	10,024	9,051	7,497	-1,554	-17.2%
American Eagle Airlines	8,975	4,637	2,480	2,206								
Delta Connection	2,531	3,355	81	1	1,489	1,082	56	38	32	63	31	96.9%
Porter Airlines			2,868	3,143	3,723	3,733	4,300	4,091	3,869	3,899	30	0.8%
Westjet Encore									2,252	3,138	886	39.3%
Non-Scheduled Operations	**2,141**	**1,068**	**305**	**300**	**268**	**277**	**185**	**248**	**63**	**65**	**2**	**3.2%**

Source: Massport.
Note: Excludes general aviation and all-cargo operations.
1 American Airlines includes US Airways beginning in 2014 (following 2013 merger).
2 Delta Air Lines totals include Northwest Airlines beginning in 2009 (following 2008 merger).

Table E-4 Logan Airport Scheduled Passenger Departures by Destination

Destination Airport	Code	2000	2005	2010	2011	2012	2013	2014	2015	2016	2017	2016-2017 Change	2016-2017 Percent Change
Domestic		**210,068**	**163,684**	**149,962**	**152,303**	**143,871**	**147,078**	**149,208**	**152,210**	**155,485**	**160,981**	**5,496**	**3.5%**
New York La Guardia	LGA	11,872	13,350	11,705	11,489	9,564	9,255	9,056	9,352	9,365	11,080	1,715	18.3%
Washington National	DCA	8,474	10,680	9,419	9,793	8,543	8,360	8,645	8,678	8,629	8,759	130	1.5%
Chicago O'Hare	ORD	10,063	7,412	7,403	7,635	7,461	7,733	7,822	7,401	7,139	6,825	-315	-4.4%
Atlanta	ATL	7,110	6,003	5,548	5,569	5,574	5,501	5,454	5,192	5,386	6,656	1,270	23.6%
New York J F Kennedy	JFK	9,899	4,985	7,054	5,969	5,428	5,919	6,139	6,745	6,971	6,391	-580	-8.3%
Baltimore	BWI	1,773	5,029	7,053	6,755	5,910	5,737	5,060	4,897	5,731	5,987	257	4.5%
Philadelphia	PHL	11,785	7,014	6,548	7,985	6,301	7,305	8,092	7,971	5,786	5,298	-488	-8.4%
New York Newark	EWR	5,206	5,626	3,666	4,608	5,228	5,702	5,532	5,366	5,239	5,169	-71	-1.3%
San Francisco	SFO	3,526	2,591	3,711	3,884	4,198	4,038	4,305	4,272	4,551	4,796	245	5.4%
Los Angeles	LAX	3,647	2,655	3,382	3,164	3,544	3,603	4,080	4,456	4,650	4,775	126	2.7%
Nantucket	ACK	5,022	3,452	3,884	3,382	3,469	3,601	3,567	4,311	4,605	4,378	-226	-4.9%
Orlando	MCO	4,914	3,517	3,179	3,580	3,496	3,399	2,883	3,057	3,323	4,234	911	27.4%
Detroit	DTW	2,937	2,827	2,353	2,437	2,314	2,340	3,354	3,875	3,932	3,849	-83	-2.1%
Charlotte	CLT	2,758	3,288	4,180	3,976	3,991	3,911	3,916	3,920	3,878	3,835	-44	-1.1%
Raleigh/Durham	RDU	3,775	4,110	3,259	2,867	3,059	3,313	3,634	3,598	3,718	3,748	30	0.8%
Dallas/Fort Worth	DFW	5,002	3,544	2,938	2,781	3,790	4,147	3,705	3,406	3,418	3,231	-187	-5.5%
Denver	DEN	2,628	1,990	2,812	2,640	2,518	2,433	2,446	2,611	2,839	2,812	-26	-0.9%
Minneapolis	MSP	3,078	1,791	1,927	2,031	2,062	2,200	2,322	2,737	2,865	2,801	-65	-2.3%
Pittsburgh	PIT	3,086	2,021	2,312	3,179	2,498	2,641	2,678	2,457	2,210	2,729	519	23.5%
Fort Lauderdale/Hollywood	FLL	3,327	3,065	2,370	2,517	2,371	2,379	2,173	2,258	2,634	2,709	75	2.9%
Martha's Vineyard	MVY	3,863	2,231	3,218	2,829	2,774	2,740	2,793	2,731	2,929	2,572	-357	-12.2%
Miami	MIA	2,068	2,072	2,238	2,555	2,610	2,555	2,551	2,520	2,523	2,519	-4	-0.2%
Washington Dulles	IAD	8,625	6,139	4,625	3,910	3,014	2,974	2,714	2,505	2,485	2,484	-1	0.0%
Richmond	RIC	1,537	1,404	1,431	1,525	1,481	1,723	2,450	2,603	2,338	2,349	12	0.5%
Buffalo	BUF	950	1,226	2,181	2,183	2,264	2,468	2,433	2,203	2,120	2,249	130	6.1%
Cleveland	CLE	2,797	1,260	1,369	1,326	1,455	1,501	1,260	2,070	2,098	2,216	118	5.6%
Fort Myers	RSW	949	1,525	1,587	1,620	1,738	1,806	1,734	1,742	1,938	2,173	235	12.1%
Tampa	TPA	2,502	1,946	1,246	1,255	1,266	1,195	1,182	1,177	1,429	2,106	678	47.4%
Nashville	BNA	642				153	588	628	688	1,467	2,058	590	40.2%
Seattle/Tacoma	SEA	458	610	1,001	993	1,051	1,378	1,607	1,625	1,907	2,051	144	7.6%
West Palm Beach	PBI	1,674	1,126	1,450	1,380	1,161	1,235	1,389	1,650	1,652	1,856	204	12.3%
Provincetown	PVC	2,023	1,659	2,410	2,086	2,054	1,982	1,929	1,957	1,912	1,610	-302	-15.8%
Phoenix	PHX	1,386	944	1,348	1,895	1,773	1,413	1,557	1,569	1,552	1,609	57	3.7%
Houston Intercontinental	IAH	1,995	1,752	1,717	1,697	1,704	1,789	1,822	1,831	1,618	1,548	-70	-4.3%
Chicago Midway	MDW	868	1,339	1,756	1,751	1,690	1,617	1,542	1,531	1,604	1,521	-83	-5.2%
Indianapolis	IND	765	2,076	1,121	977	936	895	844	1,181	1,595	1,511	-84	-5.3%
Lebanon	LEB			1,734	1,460	1,464	1,460	1,460	1,460	1,464	1,464	0	0.0%
Columbus	CMH	2,708	2,114	972	1,048	972	871	844	1,081	1,591	1,416	-175	-11.0%
Rockland	RKD	1,152	1,374	1,301	1,279	1,282	1,279	1,279	1,372	1,348	1,344	-4	-0.3%
Las Vegas	LAS	1,098	1,679	756	904	737	813	819	1,162	1,216	1,325	109	8.9%
Cincinnati	CVG	2,235	2,637	1,364	1,308	1,272	1,269	1,239	1,218	1,204	1,229	25	2.1%
Augusta	AUG	584	621	1,000	1,187	1,091	1,248	1,248	1,248	1,220	1,220	0	0.0%
Salt Lake City	SLC	1,094	730	669	438	370	584	597	617	1,009	1,156	146	14.5%
Bar Harbor	BHB	1,196	1,154	815	1,030	1,213	1,283	1,156	1,095	1,098	1,111	13	1.2%

Table E-4 Logan Airport Scheduled Passenger Departures by Destination (Continued)

Destination Airport	Code	2000	2005	2010	2011	2012	2013	2014	2015	2016	2017	2016-2017 Change	2016-2017 Percent Change
Albany	ALB	3,433	1,073	647	2,180	1,523	1,183	1,095	1,095	1,098	1,098	0	0.0%
Saranac Lake	SLK		800	1,174	1,157	1,222	1,157	1,095	1,095	1,098	1,098	0	0.0%
Rutland	RUT	1,259	643	1,095	1,148	1,160	1,095	1,095	1,095	1,098	1,098	0	0.0%
Milwaukee	MKE	1,189	2,182	2,213	1,941	1,069	880	674	854	990	1,059	70	7.0%
San Diego	SAN	366	365	571	535	476	859	1,030	1,052	1,042	1,046	4	0.4%
St. Louis	STL	2,187	1,461	934	713	815	748	722	722	745	1,021	275	36.9%
Presque Isle	PQI	1,835	1,017	991	991	993	991	991	991	993	993	0	0.0%
Houston Hobby	HOU						664	1,325	978	1,032	872	-160	-15.5%
Austin	AUS			365	365	366	352	352	444	754	855	100	13.3%
Jacksonville	JAX		428	365	544	619	593	984	767	701	854	153	21.8%
Rochester	ROC	3,644	1,181	908	886	889	878	882	886	767	806	39	5.1%
New Orleans	MSY		191	348	304	335	339	344	365	527	700	173	32.8%
Hyannis	HYA	2,274	1,059	1,165	1,047	1,028	705	731	787	775	697	-79	-10.1%
Kansas City	MCI	597	241	313	536	571	515	669	661	631	684	53	8.3%
Plattsburgh International	PBG			1,025	899	623	639	787	756	697	627	-69	-10.0%
Portland	PDX			352	440	528	615	494	519	555	599	44	7.9%
Charleston	CHS		61				398	474	365	545	593	49	8.9%
Savannah	SAV		78					306	365	370	423	52	14.1%
Westchester County	HPN	6,065	2,256						263	502	422	-80	-15.9%
Myrtle Beach	MYR	105	265	365	365	366	378	383	383	379	375	-4	-1.1%
Dallas Love Field	DAL								153	153	366	213	139.2%
Long Beach	LGB		853	459	296	292	274	270	292	297	353	56	18.9%
Syracuse	SYR	3,876	1,762	991	964	784	626	617	578	314	323	9	2.8%
San Jose	SJC	842	245	232	292	227	205	214	223	236	323	86	36.6%
Harrisburg	MDT	1,307	886	551	574	540	469	434	325	300	314	13	4.4%
Sarasota/Bradenton	SRQ		30	82	242	248	348	181	212	186	248	62	33.3%
Atlantic City Pomona Field	ACY			536	326	355	123	153	166	366	123	-243	-66.4%
Norfolk	ORF	838	1,032		511	667	613	71			105	105	
Sacramento	SMF								48	57	75	18	31.2%
Oakland	OAK		853	195	105	83	83	83	88	79	71	-9	-10.8%
Madison	MSN									9	0	-9	-100.0%
Akron/Canton	CAK		730	475	488	497	557	457	287				
Islip	ISP	4,222	1,581				293	324					
Newport News	PHF		671	549	549	60		31					
Memphis	MEM	972	1,034	1,048	1,029	688	313						
Bangor	BGR	6,644	2,946										
Greensboro	GSO	415	1,120										
Trenton	TTN												
Watertown	ART												
Burlington	BTV	5,913	1,632										
Allentown/Bethlehem	ABE	780	626										
Louisville	SDF												
Manchester	MHT												
Massena	MSS												
Dayton	DAY												
Plattsburgh	PLB												
Portland (ME)	PWM	6,267	1,394										

Table E-4 Logan Airport Scheduled Passenger Departures by Destination (Continued)

Destination Airport	Code	2000	2005	2010	2011	2012	2013	2014	2015	2016	2017	2016-2017 Change	2016-2017 Percent Change
Wilkes-Barre Scranton	AVP	584	420										
Columbia	CAE												
Ithaca	ITH	872											
Elmira/Corning	ELM	441											
Hartford	BDL												
Binghamton	BGM												
Providence	PVD	91											
International		**23,711**	**19,837**	**18,764**	**19,641**	**19,540**	**19,093**	**20,372**	**21,765**	**25,353**	**26,473**	**1,120**	**4.4%**
Toronto Pearson	YYZ	3,691	3,876	3,603	3,737	3,529	3,306	2,715	2,799	3,702	3,861	158	4.3%
Montreal-Trudeau	YUL	3,401	2,578	2,008	2,021	2,009	1,833	1,948	2,047	2,092	2,070	-22	-1.0%
Toronto Island Apt	YTZ			1,535	1,687	2,009	2,009	2,310	2,236	2,018	2,001	-17	-0.8%
London Heathrow	LHR	2,187	2,133	2,331	2,833	2,642	2,134	2,069	2,026	2,058	1,931	-127	-6.2%
San Juan	SJU	1,750	1,237	1,294	1,130	1,031	1,038	1,018	1,068	1,141	1,058	-83	-7.3%
Halifax	YHZ	3,210	1,891	852	744	745	704	704	700	955	1,037	82	8.6%
Reykjavik Keflavik Apt	KEF	393	361	404	531	467	561	614	854	968	964	-5	-0.5%
Paris De Gaulle	CDG	898	853	710	946	619	784	780	916	938	895	-44	-4.7%
Dublin	DUB	223		348	457	480	605	653	653	694	816	122	17.6%
Ottawa	YOW	2,575	864	744	696	623	652	635	630	649	623	-26	-4.0%
Bermuda	BDA	550	518	532	540	511	501	523	536	510	598	88	17.2%
Aruba	AUA	9	338	407	426	405	408	417	417	471	597	126	26.7%
Amsterdam	AMS	366	365	457	553	558	575	536	579	580	580	0	0.0%
Dubai	DXB							306	457	692	518	-174	-25.2%
Frankfurt	FRA	580	575	548	544	572	545	532	536	515	502	-13	-2.5%
Zurich	ZRH	523	356	365	365	366	365	365	365	366	467	101	27.6%
Santo Domingo	SDQ		174	305	275	358	339	401	365	519	406	-113	-21.8%
Tokyo Narita	NRT					236	352	365	365	357	366	9	2.4%
Munich	MUC		210	313	335	357	348	357	357	357	366	9	2.4%
Beijing	PEK							136	287	323	366	43	13.4%
Panama City	PTY							365	334	318	366	48	15.1%
Doha	DOH									284	366	82	28.9%
Lisbon	LIS	44		26	26	48	39	39	44	223	362	139	62.2%
Shannon	SNN	366	737	213	118	144	166	348	352	349	331	-18	-5.1%
Cancun	CUN		207	307	270	217	225	273	264	326	331	5	1.5%
Hong Kong	HKG								140	227	327	100	44.2%
Copenhagen	CPH									293	314	21	7.3%
Ponta Delgada	PDL	30	39	165	170	148	179	209	196	196	314	118	59.9%
Istanbul	IST							236	365	340	310	-30	-8.9%
Mexico City	MEX		234						166	292	301	9	3.0%
Santiago	STI				92	201	214	248	206	275	284	8	3.0%
Rome Leonardo Da Vinci-Fiumicino	FCO		135	313	314	266	271	258	271	271	275	4	1.6%
Punta Cana	PUJ			95	92	139	134	160	174	214	261	48	22.4%
Madrid	MAD			218	231	222	209	166	166	205	258	53	25.7%
London Gatwick	LGW	362								161	218	56	35.0%
Dusseldorf	DUS									101	197	96	95.3%
Saint Thomas	STT	78	108	125	117	156	173	176	184	186	186	1	0.5%

Table E-4 Logan Airport Scheduled Passenger Departures by Destination (Continued)

Destination Airport	Code	2000	2005	2010	2011	2012	2013	2014	2015	2016	2017	2016-2017 Change	2016-2017 Percent Change
Shanghai Pudong	PVG								83	157	157	0	0.0%
Tel Aviv	TLV								75	148	157	9	5.9%
Manchester	MAN	26	241							31	122	91	294.5%
Bogota	BOG										122	122	
Montego Bay	MBJ		238	126	52	69	56	73	56	52	118	65	125.5%
Nassau	NAS		100	180	134	142	108	139	136	133	109	-24	-18.3%
Saint Maarten	SXM			39	43	61	61	52	56	91	95	4	4.5%
Providenciales	PLS	4	43	39	26	69	52	82	86	104	91	-13	-12.2%
Barbados	BGI								9	43	74	31	70.4%
Terceira	TER	44		17	17	17	17	17	31	70	70	0	0.0%
Vancouver	YVR	366	62								62	62	
Port Au Prince	PAP								26	53	62	9	17.4%
Oslo	OSL									57	61	4	7.5%
Fort-de-France	FDF								9	43	26	-17	-40.1%
Pointe-a-Pitre	PTP								9	30	26	-4	-14.6%
Grand Cayman	GCM		31	17		9	26	26	26	43	26	-17	-39.9%
Liberia	LIR							9	26	26	26	0	0.0%
Puerto Plata	POP	4						9	26	26	26	0	0.0%
St. Lucia Hewanorra	UVF							9	26	26	22	-4	-16.5%
Cologne/Bonn	CGN									52		-52	-100.0%
Praia	RAI		9	121	122	109	104	92	30				
Sao Vicente	VXE			4		4							
Charlottetown	YYG												
Helsinki	HEL												
Milan Malpensa	MXP	366	343										
Fredericton	YFC		686										
Quebec	YQB	1,229	30										
Glasgow	GLA												
Connaught	NOC												
Stockholm Arlanda	ARN												
Las Palmas	LPA												
San Salvador	SAL		178										
Ilha Do Sal	SID		56										
Nykoping	NYO		31										
Lerwick Sumburgh Apt	LSI												
Freeport	FPO												
Brussels	BRU	362											
Gander	YQX												
Athens	ATH	74											
Total Scheduled Carrier Operations		**233,779**	**183,520**	**168,726**	**171,945**	**163,411**	**166,171**	**169,579**	**173,974**	**180,838**	**187,454**	**6,616**	**3.7%**

Source: OAG Schedules.

Logan Airport Activity Forecast Methodology and Assumptions

Introduction

The Massachusetts Port Authority (Massport) developed high-level strategic planning forecasts for Boston Logan International Airport (Logan Airport or the Airport) in 2017. These forecasts serve as the basis for Massport's airport and ground transportation planning initiatives and analyses of future environmental impacts. The objective of forecasting is to develop a realistic measure of future growth such that preparations can be made to effectively accommodate its impact on airport facilities. Factors that can influence aviation activity levels include regulatory policy on the local and national level, technological innovations, aviation industry trends, and regional fluctuations in population and employment.

The base year for the forecasts was 2017 with a future horizon of 50 million air passengers, or about 10 to 15 years into the future (Future Planning Horizon). The future forecast was derived by applying standard industry forecasting techniques analyzing: 1) historical trends; 2) recent developments; and 3) outlook for future demand drivers such as the economy and airfares. The forecast is presented below and serves as the basis for the planning, ground traffic, and environmental impacts analyses in the *2017 Environmental Status and Planning Report (2017 ESPR)*. The scope of the planning forecast for Logan Airport included projections of passengers (domestic and international), cargo, and aircraft operations (scheduled passenger, all cargo, charter and general aviation [GA]). Based on the moderate forecast scenario, Massport developed derivative forecasts to support the air quality, noise, and vehicle miles traveled (VMT) analyses for the *2017 ESPR*. The derivative forecasts include the aircraft fleet mix, average daily operations by aircraft type and stage length, and peak month, busy day, activity.

Summary

Table E-5 provides a summary of the 2017 actual and Future Planning Horizon forecast passengers, cargo volume, and aircraft operations at Logan Airport. Enplaned and deplaned passengers are projected to grow by 1.5 percent annually to about 50 million in the Future Planning Horizon. Passenger aircraft operations are forecast to grow by 1.2 percent annually, all-cargo operations are forecast to grow by 0.5 percent annually, and GA operations are forecast to increase by 0.1 percent annually.

Table E-5 Actual and Forecast Logan Airport Passengers, Cargo, and Aircraft Operations, 2017 and Future Planning Horizon[1]

Category	2017 Actual	Future Planning Horizon	Compound Annual Growth (2017-Future Planning Horizon)
Passengers	38,412,419	50,113,905	1.5%
Cargo[2] (pounds)	679,407,977	828,551,499	1.1%
Operations (Passengers)	363,507	447,302	1.2%
Operations (All-Cargo)	6,744	7,377	0.5%
Operations (GA)	31,120	31,685	0.1%

Source: Massport and Inter*VISTAS* 2017 Logan Airport Long-Range Forecast
1 Represents the 10- to 15-year planning horizon.
2 Includes freight and express/small packages. Does not include mail.

Updated Logan Airport Planning Forecast

Massport periodically assesses and updates planning forecasts due to global and local economic and market conditions that have a bearing on aviation activity levels. Logan Airport's passenger traffic reached 38.4 million air passengers in 2017, and that growth continued into 2018, reaching 40.9 million air passengers. The growth is in direct response to the strong national and regional economy. This peak follows unprecedented, consistent growth since 2013 at a 6.2-percent annual average growth, making Logan Airport one of the fastest growing airports in the U.S. in terms of passenger activity levels. The seven-year period of growth since 2010, on which the previous forecast was based, has added almost 11 million new air passengers, equaling a 40-percent increase between 2010 and 2017.

In addition to the national aviation trends described above, since the publication of the *2011 ESPR*, there have been several developments that have affected aviation within the New England region and that have had implications for activity levels at Logan Airport. These include the following:

- Strong economic conditions in Boston including a substantial increase in per capita income compared to the rest of the U.S.
- New international non-stop services led by foreign flag carriers including, but not limited to: Emirates, Qatar Airways, Turkish Airlines, El Al, Cathay Pacific Airways, TAP Air Portugal, Norwegian, and WestJet. These airlines have all entered the Boston market, stimulating local inbound and outbound international passenger demand.
- jetBlue Airways' strategy of forging relationships with the foreign flag carriers in order to facilitate increased connections from jetBlue's Boston network. Markets such as Detroit and Raleigh/Durham connect an increasingly significant number of passengers through Boston onto a diverse group of foreign flag airlines.
- Continued growth by jetBlue Airways and Delta Air Lines. Both carriers have indicated to Massport they will plan to increase the number of departures 10 percent per year at Logan Airport until they reach 200 and 150 daily departures respectively. Southwest Airlines is also expected to expand service in the near future in response to anticipated additional demand.

Passenger Forecast

The region's economic growth is the primary driver of current and future air passenger growth at Logan Airport. Logan Airport serves the 10th largest metropolitan area in the nation. Residents of the Boston metropolitan area have above average incomes and a high propensity for personal and business-related airline travel. Since no airline maintains a connecting hub operation at the Airport, Logan Airport is principally an origin and destination (O&D) airport. Future passenger levels are therefore largely determined by underlying market demand and are not dependent on airlines connecting passengers that transfer from one flight to another. The price of airline travel, which is inversely related to passenger growth, is another factor that affects passenger demand over the long term. Real increases in the price of airline travel (i.e., adjusted for inflation) tend to moderate growth in airport passenger levels. Conversely, price reductions may lead to passenger growth as lower prices entice more people to travel. In the current and foreseeable future operating climate, the price of airline travel is strongly linked to fuel prices.

Rapid technology advances in the aviation sector also have the potential to impact passenger demand and growth. Disruptive technologies affecting the journey to and from the Airport, the ticketing lobby, passenger security, and the experience in the concourse are being developed to improve the passenger experience. Aircraft manufacturers are developing electric and hypersonic aircraft. Biofuels for aircraft are being tested, which will reduce greenhouse emissions. Autonomous flight continues to be researched. For airlines, replacing pilots with technology could lead to major cost savings; the industry could save as much as $30 billion by adopting autonomous flight technology. The long-term impact of disruptive technology advances on passenger activity are still uncertain, however. Therefore, these technological advances are not factored into the Logan Airport passenger forecast.

The passenger forecasts were prepared using standard industry forecasting techniques analyzing: (1) historical patterns of passenger traffic at the Airport; (2) recent trends at the Airport and in the industry; and (3) the outlook for future aviation demand based on economic factors. More specifically, the long-term forecast was based on over 10 years of historical relationships between the main drivers of air traffic demand at Logan Airport: the economy, airfares, and its local share of regional demand **(Table E-6)**.

Table E-6 Passenger Forecast Assumptions

Input[1]	Assumptions Average Annual Growth (through Future Planning Horizon[2])
U.S. Gross Domestic Product (GDP)	2.3%
Regional GDP	2.0%
Regional Total Personal Income	2.2%
Cost of Fuel	1.5%

Source: Inter*VISTAS* 2017 Logan Airport Long-Range Forecast, Woods & Poole.
Notes: Regional defined as the states of MA, RI, and NH.
1 These inputs were updated from the *2011 ESPR*.
2 10- to 15-year timeframe.

Domestic passenger activity levels are forecast to grow by 1.5 percent annually from 31.1 million in 2017, to 40.8 million in the next 10 to 15 years, while international passengers are forecast to grow by 1.4 percent annually from 7.2 million in 2017 to 9.2 million over the same timeframe (see **Table E-7**). Average growth rates in the early years of the forecast are higher than for the overall forecast average due to the inclusion of industry knowledge and airline expansion plans. Growth rates level off in the later years as the forecast relies on economic modeling to predict future passenger demand beyond the initial short-term period.

In the future, domestic passengers are expected to represent approximately 81 percent of all passengers, similar to the proportion or domestic passengers in 2017. The fastest growing international market segment is Central and South America with a projected 3.6-percent annual growth rate. Asia and the Pacific region are forecast to grow by 2.0 percent, with Europe and the Middle East growing by 2.0 percent, and Canada by 1.0 percent. Europe remains Logan Airport's most mature international market. GA passenger traffic is anticipated to remain relatively stable; it is forecast to grow 0.1 percent annually, increasing from 111,874 in 2017 to approximately 114,000 in the next 10 to 15 years.

Overall, passenger activity levels are expected to increase to approximately 50 million annual air passengers and operations are expected to increase to approximately 486,000 in the next 10 to 15 years (the Future Planning Horizon). In this *2017 ESPR,* the Future Planning Horizon activity level serves as the basis for assessing future environmental impacts of airport operations. This increase in projected passenger levels is consistent with previous ESPR analyses.

Over the past 10 years, the U.S. economy has experienced an unprecedented cycle of growth, which has led to significant airline profits and record-breaking passenger levels at U.S. airports. By most statistical measures, the economy is doing well and has rebounded from the 2008/2009 recession. The economy grew nearly 3 percent in 2018 for the second time since the downturn.[1] Although the current economic expansion is the second-longest in U.S. history, many leading economists are forecasting a recession in the near future.

Logan Airport has consistently been resilient to external shocks and periods of weak demand in the past. With a diversified mix of airlines, a thriving regional economy, and a strong local originating and inbound visitor passenger market, the Airport is well positioned to withstand future external shocks. Furthermore, as mentioned above, increased reliance on additional revenue streams (e.g., co-branded credit cards, baggage, on-board food sales) will help sustain airlines during downturns. These factors can help to limit shocks, not just at Logan Airport, but at airports across the country.

1 U.S. Department of Commerce, Bureau of Economic Analysis. 2018. U.S Economy at a Glance Table. https://www.bea.gov/media/3531.

Table E-7 Actual and Forecast Logan Airport Passengers, 2017 and Future Planning Horizon[1]

Passengers	2017	Future Planning Horizon	Average Annual Growth (2017 - Future Planning Horizon)
Scheduled/Charter			
Domestic	**31,100,950**	**40,797,282**	**1.5%**
International	**7,199,595**	**9,202,718**	**1.4%**
Europe/Middle East	4,360,706	6,275,187	2.0%
Canada	1,000,634	1,203,852	1.0%
Bermuda/Caribbean	1,100,769	556,193	(3.7%)
Asia/Pacific	503,386	722,504	2.0%
Central/South America	234,100	444,981	3.6%
Total Scheduled/ Charter	**38,300,545**	**50,000,000**	**1.5%**
General Aviation	111,874	113,905	0.1%
Total Passengers	**38,412,419**	**50,113,905**	**1.5%**

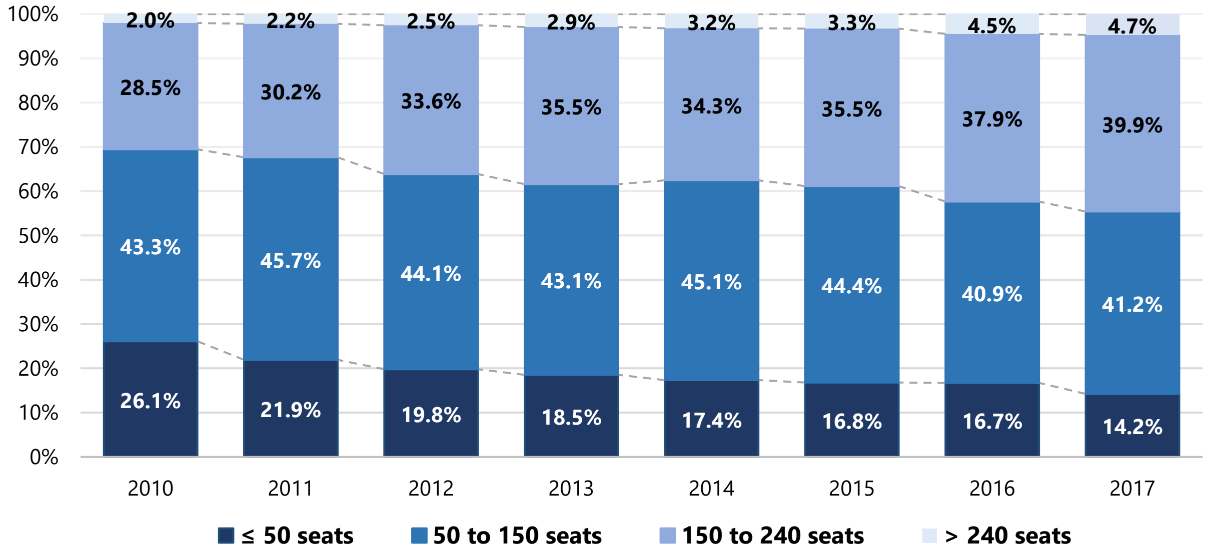
Source: Massport and InterVISTAS 2017 Logan Airport Long-Range Forecast.
1 Represents the 10- to 15-year planning horizon.

Aircraft Operations and Fleet Mix Forecast

Air passenger numbers have increased by 38.5 percent from 2000 to 2017 (**Table E-1**), while aircraft operations have decreased by 17.8 percent, demonstrating more efficient operations. The decline in aircraft operations has resulted from increasing load factors and the introduction of larger aircraft into the market. Between 2010 and 2017, the number of seats per operation increased by over 15, as smaller regional jets and turbo-props were replaced with larger narrow-body aircraft (see **Figure E-1**). The number of aircraft operating with 50 or fewer seats was nearly cut in half during this time, as airlines began taking deliveries of larger aircraft in the Boeing 737 and Airbus A320 families as well as the larger two-class regional jets.

Average load factors are forecast to increase for North American, European, and Asian flights to 86.6 percent, 87.6 percent, and 89.7 percent, respectively, and to decrease slightly for flights to Latin America by 0.5 percent. Average seats per operation are forecast to increase in all regions with the exception of Europe and the Middle East. Average seats per operation are forecast to increase from about 115 to 125 for North America, from about 254 to 265 for Asia, and from about 146 to 154 for Latin America. European destinations are expected to see more long-range, narrow-body aircraft operations, leading to a decrease in average seats per operations from 257 to 251 in the future (see **Table E-8)**.

Figure E-1 Evolution of Aircraft Fleet Mix at Logan Airport, 2010-2017



Source: Inter*VISTAS* 2017.

Table E-8 Average Load Factors and Average Aircraft Size, 2017 and Future Planning Horizon[1]

	Average Load Factors		Average Seats Per Operation	
Region	**2017**	**Future Planning Horizon**	**2017**	**Future Planning Horizon**
North America	85.2%	86.6%	115.1	125.1
Europe/Middle East	79.5%	87.6%	257.0	251.0
Asia	80.9%	89.7%	253.8	265.2
Latin America	86.1%	85.6%	145.7	154.2
Total	**83.2%**	**86.7%**	**124.4**	**134.7**

Source: Inter*VISTAS*, U.S. Department of Transportation T-100 Database.
1 Represents the 10- to 15-year planning horizon.

As shown in **Table E-9**, Logan Airport's total aircraft operations are forecast to increase slightly at an annual rate of 1.1 percent from 2017 through the Future Planning Horizon. All-cargo aircraft operations are forecast to grow at 0.5 percent annually, however the largest absolute growth is still expected to come from passenger aircraft operations with jet aircraft operations increasing by 59,901. Passenger jet operations are expected to increase by 1.1 percent per year, regional jet (RJ) operations are forecast to increase by 2.7 percent per year, and non-jet operations are expected to grow 0.1 percent annually. GA operations are forecast to grow by 0.1 percent annually between 2017 and the Future Planning Horizon, as there has been a national decrease in personal and hobby flying that is somewhat offset by increasing demand for and popularity of business jets.

RJ operations with aircraft less than 100 seats will continue to increase (e.g., Embraer 175, CRJ-900) as airlines replace smaller, 50-seat, regional aircraft. Non-jet aircraft will remain stagnant as there are no to very limited replacement options for propeller aircraft. Cape Air is expected to continue to operate small propeller aircraft and replace its aging aircraft with similar types of aircraft.

Table E-9 Actual and Forecast Logan Airport Operations, 2017 and Future Planning Horizon[1]

Operations	2017	Future Planning Horizon	Difference (2017-Future Planning Horizon)	Compound Annual Growth (2017-Future Planning Horizon)
Passenger				
Jet	279,464	339,365	59,901	1.1%
Regional Jet	39,279	62,857	23,578	2.7%
Non-Jet	44,764	45,079	315	0.1%
Subtotal	363,507	447,302	83,795	1.2%
All-Cargo	6,744	7,377	633	0.5%
General Aviation	31,120	31,685	565	0.1%
Total Operations	401,371	486,364	84,993	1.1%

Source: Massport and Inter*VISTAS*, U.S. Department of Transportation T-100 Database.
Notes: Totals may not add exactly due to rounding
1 Represents the 10- to 15-year planning horizon.

While Logan Airport's passenger levels continue to reach historical highs, aircraft operations in 2017 are well below the historic high in 1998 of 507,000. From 2000 to 2017, the annual number of passengers at Logan Airport increased by 38.5 percent, while the annual number of aircraft operations decreased by 17.8 percent. The declining operations resulted from the accelerated removal of turbo-prop aircraft, the addition of larger aircraft, and increasing load factors. The airlines serving Logan Airport were able to accommodate a greater number of passengers at lower service levels. This trend is expected to continue through the Future Planning Horizon with forecast operations of 486,364. Increasing aircraft capacity and increasing load factors will drive the slower growth in aircraft operations as compared to the passenger growth.

Cargo Forecast

Historically, changes in air cargo activity have mirrored those of gross domestic product (GDP), but declining unit revenues, improved productivity, and globalization of the air cargo industry have also affected the growth in air cargo traffic. Furthermore, the air cargo industry has seen significant structural changes as well. Among these changes are air cargo security regulations issued by the Federal Aviation Administration (FAA) and the Transportation Security Administration (TSA), maturation of the domestic express market, a shift from air to

other transport modes (primarily truck), and the growth in international trade from the Open Skies[2] agreements.

Similar to the airline industry, cargo activity at Logan Airport has also undergone significant changes. The unprecedented growth in long-haul international commercial air service has led to an increase in international cargo of 71 percent since 2010. Among the top 10 U.S. airports, Logan Airport was the fastest growing airport for wide-body flights over the past five years. Carried in the aircraft belly compartment, international cargo ("international belly") is a key contributor to the profitability of long-haul international passenger services. International cargo now accounts for approximately 39 percent of Logan Airport's cargo shipments, up from 27 percent in 2010. International cargo is forecast to grow by an annual rate of 1.7 percent through the Future Planning Horizon and represent 43 percent of the Airport's total cargo.

The integrated cargo airlines, dominated by FedEx and UPS, currently account for 92 percent of the domestic cargo market at Logan Airport. The domestic commercial airlines at the Airport have become increasingly less dependent on cargo. In late 2015, jetBlue Airways made a strategic decision not to carry cargo system-wide.

The total volume of cargo at Logan Airport is forecast to increase by 1.1 percent annually from approximately 679 million pounds in 2017 to 829 million pounds in the Future Planning Horizon. International belly is forecast to grow the fastest at 1.7 percent per year as the growth in international wide-body aircraft operations continues. The express all-cargo market is projected to increase by 0.8 percent a year, while the domestic belly market is forecast to decrease by 0.4 percent per year **(Table E-10).**

Table E-10 Actual and Forecast Logan Airport Express/Freight (in pounds), 2017 and Future Planning Horizon[1]

Type	2017	Future Planning Horizon	Average Annual Growth (2017-Future Planning Horizon)
Domestic Belly	37,604,311	35,296,758	(0.4%)
International Belly	265,794,588	357,928,053	1.7%
Express All-Cargo	376,009,078	435,326,688	0.8%
Total	679,407,977	828,551,499	1.1%

Source: Massport and InterVISTAS 2017 Logan Long Range Forecast.
Notes: Numbers in parentheses ( ) indicate negative numbers.
1 Represents the 10- to 15-year planning horizon.

2 Open Skies Agreements – Since 1992, the U.S has pursued an "open-skies" policy designed to eliminate government involvement in airline decision-making about routes, capacity, and pricing in international markets. Open Skies agreements have vastly expanded international passenger and cargo flights to and from the U.S., promoting increased travel and trade, enhancing productivity, and spurring high-quality job opportunities and economic growth. The U.S. has reciprocal Open Skies air transport agreements with over 120 partners.

Derivative Forecasts

Derivative forecasts based on the Future Planning Horizon were developed to support the air quality, noise, and VMT analyses for the *2017 ESPR*. The derivative forecasts include:

- Annual aircraft operations by aircraft type (to support air quality modeling);
- Average daily arriving and departing operations by aircraft type and stage length (to support noise modeling); and
- Peak month, busy day, arriving and departing origin-destination passengers by time of day (to support VMT modeling).

Aircraft Fleet Forecast

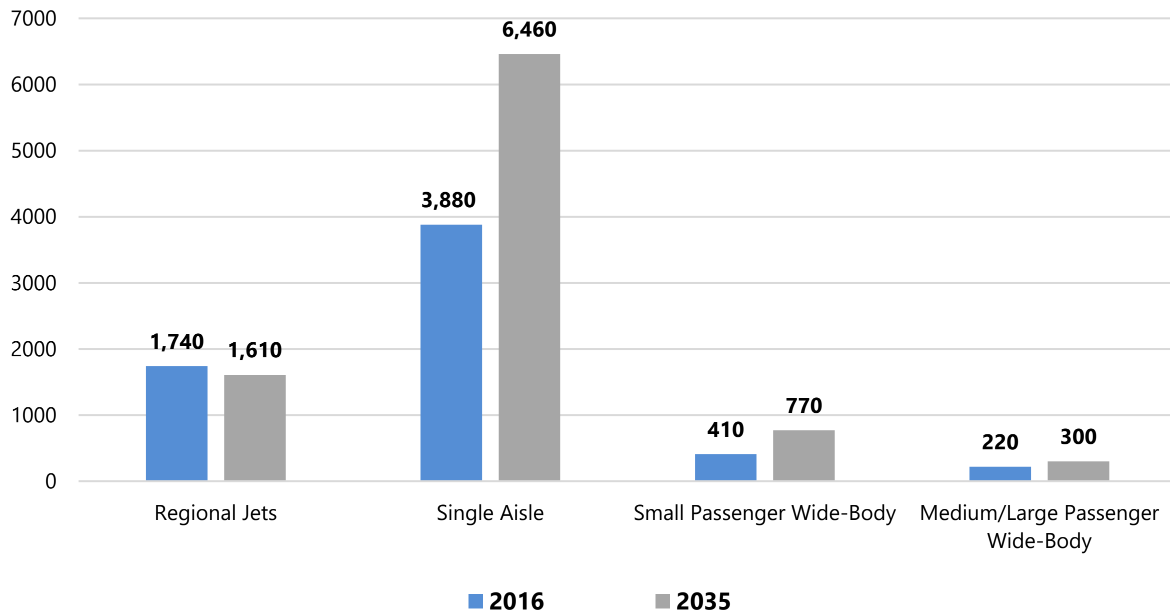
The Future Planning Horizon operations forecast is based on anticipated changes in passenger airline fleets both in North America and worldwide. The 2017 Boeing Current Market Outlook and the 2017 Airbus Global Market Forecast served as guiding documents for the aircraft fleet mix projections. These aircraft manufacturer reports are the result of comprehensive modeling of a number of factors, and they serve as industry standards for accurately forecasting changes in airplane demand.

Passenger Airlines

The North American passenger airline fleet is projected to grow 46 percent between 2016 and 2035,[3] with single aisle aircraft accounting for nearly 90 percent of that growth. Conversely, the RJ fleet is expected to contract in the future, yielding share to the single aisle segment. Small wide-body passenger airplanes are also projected to become more important for additional international non-stop flights as well as for serving secondary markets. **Figure E-2** summarizes the changes in fleet composition from 2016 to 2035. The number of RJs is expected to decrease from 1,740 to 1,610, the number of single aisle aircraft is expected to increase from 3,880 to 6,460, small passenger wide-bodies are forecast to grow from 410 to 770, and medium/large passenger wide-body aircraft are forecast to grow from 220 to 300.

3 The Boeing Market Outlook looks ahead 20 years and uses the timeframe from 2016 to 2035, which is the most applicable time period available for reference.

Figure E-2 Actual and Forecast North American Passenger Airline Aircraft Fleet, 2016 and 2035



Source: Boeing Current Market Outlook, 2017.
Note: The Boeing Market Outlook looks ahead 20 years and uses the timeframe from 2016 to 2035, which is the most applicable time period available for reference.

New aircraft types are expected to introduce market opportunities for passenger service at Logan Airport, in addition to replacing older, aging aircraft types. The Boeing 737 MAX[4] and the Airbus 320neo (new engine option) narrow-body family of aircraft can become important players in introducing thin, international destinations. New long-haul destinations will be served with modern wide-body aircraft, such as the Boeing 787 and the Airbus 350. Airbus 380 operations are forecast to be present in the Future Planning Horizon, operating to large international hub airports. However, no growth is expected in this more than 400-seat, ultra-wide-body segment. Operations with small RJs are forecast to decline, as airlines shift to larger RJs, such as the Embraer E175 and CRJ-900.

Table E-11 summarizes the existing 2017 and forecast Future Planning Horizon aircraft fleet mix for scheduled passenger airlines at Logan Airport. Over the forecast period, it is assumed that Cape Air will continue to serve Cape Cod and Massachusetts Island markets, as well as small Essential Air Service markets, from Logan Airport with small piston powered aircraft (nine seats). Piston operations are assumed to remain relatively constant over the forecast period.

Operations of RJs with 50 or fewer seats are forecast to decline, reflecting the decline in the number of small RJs in airline fleets. In addition, there is currently no aircraft in development to replace these aging 50 seat RJs.

4 As of the publication of this report, all Boeing 737 MAX 8 aircraft were grounded per order of the Federal Aviation Administration.

Overall, the percentage of operations with aircraft having 50 or fewer seats is forecast to decline from 4.6 percent in 2017 to 2.1 percent in the Future Planning Horizon.

Activity in turboprops and RJs with more than 50 seats is forecast to increase as airlines add more of these types of aircraft to their fleets. Increases are also projected for small and large narrow-bodies with a notable shift to large narrow-bodies with over 150 seats. In the Future Planning Horizon, the large narrow-body category will account for approximately 44.3 percent of scheduled airline operations compared to 39.4 percent in 2017. Increases in wide-body aircraft operations are also projected to support growth in international air travel demand. Strong growth in the wide-body aircraft, especially those with more than 240 seats, reflects the introduction of the larger variations of the fuel-efficient Boeing 787 Dreamliner and Boeing 777 aircraft. These mid-sized aircraft are ideally suited for serving long-haul markets from Logan Airport.

Table E-11 Scheduled Passenger Airline Operations by Aircraft Category, Actual 2017 and Future Planning Horizon[1]

Aircraft Category	Actual 2017 Operations	Percent of Total	Future Planning Horizon Operations	Percent of Total	Percent Change (2017-Future Planning Horizon)
Pistons	33,235	9.1%	33,016	7.4%	(0.7%)
TP ≤ 50 seats	4,477	1.2%	4,444	1.0%	(0.7%)
TP > 50 seats	7,052	1.9%	7,619	1.7%	8.0%
RJ ≤ 50 seats	12,310	3.4%	5,079	1.1%	(58.7%)
RJ > 50 seats	26,969	7.4%	57,778	12.9%	114.2%
NB ≤ 150 seats	114,596	31.5%	115,238	25.8%	0.6%
NB > 150 seats	143,041	39.4%	198,095	44.3%	38.5%
WB ≤ 240 seats	2,942	0.8%	3,175	0.7%	7.9%
WB > 240 seats	18,885	5.2%	22,857	5.1%	21.0%
Total	363,507	100.0%	447,302	100%	23.1%

Source: Massport and Inter*VISTAS*.
Notes: Numbers in parentheses ( ) indicate negative numbers.
TP – turboprop, RJ – regional jet, NB – narrow-body, WB – wide-body
1 Represents the 10- to 15-year planning horizon.

Cargo Airlines

FedEx and UPS continue to dominate cargo operations at Logan Airport. These two carriers have started retiring their aging Airbus 300/310 and MD-10/11 fleets and replacing them primarily with Boeing 757F and 767F aircraft. Narrow-body and wide-body cargo jet aircraft operations are both forecast to grow, as summarized in **Table E-12**. A 9.4-percent increase in cargo operations is expected to occur between 2017 and the Future Planning Horizon with no non-jet cargo aircraft.

Table E-12 Cargo Airline Operations by Aircraft Category, Actual 2017 and Future Planning Horizon[1]

Aircraft Category	Actual 2017 Operations	Percent of Total	Future Planning Horizon Operations	Percent of Total	Percent Change (2017-Future Planning Horizon)
Narrow-body Jet	580	8.6%	1,302	17.6%	124.5%
Wide-body Jet	5,778	85.7%	6,075	82.4%	5.1%
Non-Jet	386	5.7%	0%	0.0%	(100.0%)
Total	6,744	100.0%	7,377	100.0%	9.4%

Source: Massport and InterVISTAS
Notes: Numbers in parentheses ( ) indicate negative numbers.
1 Represents the 10- to 15-year planning horizon.

General Aviation

GA aircraft are organized by aircraft category for the purpose of this report. The categories are: single-engine piston, multi-engine piston, business jet, and turbo-prop. A balanced growth is expected in all four categories. Business jet operations are expected to grow at a slightly higher rate due to increasing demand and popularity of these aircraft, while piston aircraft are expected to grow a lower rate due to the national decline in personal and hobby flying.

Table E-13 provides a detailed summary of the Future Planning Horizon forecast by user category and aircraft type.

Table E-13 Forecast Logan Airport Operations by Aircraft Type, Actual 2017 and Future Planning Horizon[1]

Category/Aircraft Type	2017 Operations	Future Planning Horizon Operations
Scheduled + Charter Passenger Airlines		
Airbus A220-100	0	5,714
Airbus A220-300	0	57,143
Airbus A310	768	0
Airbus A319	21,023	30,476
Airbus A319 NEO	0	317
Airbus A320	57,592	62,857
Airbus A320 NEO	0	8,889
Airbus A321	23,431	32,063
Airbus A321 NEO	30	17,460
Airbus A330-200	5,861	1,270
Airbus A330-300	1,987	5,714
Airbus A330-900 NEO	0	3,175
Airbus A340-200	44	0
Airbus A340-300	330	0
Airbus A340-500	9	0

Table E-13 Forecast Logan Airport Operations by Aircraft Type, Actual 2017 and Future Planning Horizon[1] (Continued)

Category/Aircraft Type	2017 Operations	Future Planning Horizon Operations
Airbus A340-600	190	0
Airbus A350-900	1,221	1,270
Airbus A380	184	635
ATR 42-600	0	1,270
Boeing 717-200	5,476	3,175
Boeing 737-300	3,233	0
Boeing 737-400	102	0
Boeing 737-700	17,885	15,238
Boeing 737 MAX 7	0	3,175
Boeing 737-800	36,623	35,238
Boeing 737 MAX 8	32	20,000
Boeing 737-900	14,396	13,333
Boeing 737 MAX 9	0	5,079
Boeing 747-400	900	0
Boeing 747-8	687	635
Boeing 757-200	7,383	0
Boeing 757-300	2,053	3,175
Boeing 767-200	4	0
Boeing 767-300	2,089	635
Boeing 767-400	28	0
Boeing 777-200	2,316	3,810
Boeing 777-300	2,098	1,905
Boeing 777-9	0	635
Boeing 787-8	83	2,540
Boeing 787-9	3,036	3,810
Cessna 402	33,235	0
Bombardier Canadair Regional Jet 200	9,464	0
Bombardier Canadair Regional Jet 700	2,872	1,905
Bombardier Canadair Regional Jet 705	705	0
Bombardier Canadair Regional Jet 900	9,495	18,413
De Havilland DHC-8 Dash 8-100	86	0
De Havilland DHC-8 Dash 8-300	58	0
De Havilland DHC-8 Dash 8-400	7,052	7,619
Embraer 140	0	4,444
Embraer 145	2,844	635
Embraer 170	4,508	8,254
Embraer 175	9,389	29,206
Embraer 190	65,824	0

Table E-13 Forecast Logan Airport Operations by Aircraft Type, Actual 2017 and Future Planning Horizon[1] (Continued)

Category/Aircraft Type	2017 Operations	Future Planning Horizon Operations
McDonnell Douglas MD-80	1,150	0
McDonnell Douglas MD-90	1,482	0
Pilatus PC-12	945	0
Saab SF 340	3,388	3,175
Tecnam P2012 Traveler	0	33,016
Subtotal	**363,507**	**447,302**
Cargo Airlines		
Airbus 300-600	2,110	0
Airbus A310-200	224	0
Antonov An-124	6	0
Boeing 727-200	6	0
Boeing 757-200	574	1,302
Boeing 767-200	214	0
Boeing 767-300	2,475	6,075
Cessna 208	386	0
McDonnell Douglas MD-10	571	0
McDonnell Douglas MD-11	178	0
Subtotal	**6,744**	**7,377**
General Aviation		
Multi-engine piston	565	575
Business Jet	24,306	24,802
Single-engine piston	1,152	1,163
Turboprop	4,839	4,887
Helicopter	258	258
Subtotal	**31,120**	**31,685**
Grand Total	**401,371**	**486,364**

Source: Inter*VISTAS*.
Notes: Totals may not add exactly due to rounding
1 Represents the 10- to 15-year planning horizon.

Operations by Stage Length and Time-of-Day

A forecast of aircraft operations by stage length and time of day has also been developed for the Future Planning Horizon. An average day, peak month future schedule was developed with consideration to the aforementioned aircraft fleet mix expectations, and the stage length was analyzed directly from this schedule.

The stage length assumptions specific to North American operations and long-haul international operations are summarized in **Tables E-14** and **E-15**. In North America, more than a quarter of the operations have stage lengths longer than 1,000 nautical miles, but flights with stage lengths up to 500 nautical miles continue to dominate operations at Logan Airport. An increase in the international long-haul operations can be seen for flights with stage lengths of more than 5,500 nautical miles due to flights to the Middle East and Asia. Stage lengths between 2,501 and 3,500 nautical miles will continue to dominate, which mostly consists of flights to European destinations.

Table E-14 Stage Length Assumptions, North American Scheduled Passenger Airline Operations, Future Planning Horizon[1]

Stage Length (nm)	Pistons	TP ≤ 50	TP > 50	RJ ≤ 50	RJ > 50	NB ≤ 150	NB > 150	WB ≤ 240	WB > 240	Total	Percent of Total
0 to 500	33,016	4,444	7,619	5,079	36,825	75,453	19,631	0	0	182,069	44%
501 to 1,000	0	0	0	0	15,873	33,578	60,270	0	0	109,721	27%
1,001 to 1,500	0	0	0	0	5,079	3,145	53,293	0	0	61,518	15%
1,501 to 2,500	0	0	0	0	0	1,255	54,559	0	1,270	57,084	14%
Total	**33,016**	**4,444**	**7,619**	**5,079**	**57,778**	**113,431**	**187,754**	**0**	**1,270**	**410,391**	**100%**

Source: Inter*VISTAS*.
Notes: Totals may not add exactly due to rounding
nm – nautical miles
TP – Turboprop
RJ – Regional jet
NB – Narrow-body jet
WB – Wide-body jet
1 Represents the 10- to 15-year planning horizon.

Table E-15 Stage Length Assumptions, Long-Haul International Scheduled Passenger Airline Operations, Future Planning Horizon[1]

Stage Length (nm)	NB ≤ 150	NB > 150	WB ≤ 240	WB > 240	Total	Percent of Total
1,501 to 2,500	1,573	3,810	635	0	6,017	16%
2,501 to 3,500	0	6,338	1,905	15,209	23,452	64%
3,501 to 4,500	0	0	635	1,270	1,905	5%
4,501 to 5,500	0	0	0	635	635	2%
5,501 to 6,500	0	0	0	3,810	3,810	10%
Over 6,500	0	0	0	635	635	2%
Total	**1,573**	**10,148**	**3,175**	**21,558**	**36,453**	**100%**

Source: Inter*VISTAS*.
Notes: Totals may not add exactly due to rounding
nm – nautical miles
TP – Turboprop
RJ – Regional jet
NB – Narrow-body jet
WB – Wide-body jet
1 Represents the 10- to 15-year planning horizon.

Tables E-16 and **E-17** summarize stage length assumptions for cargo operations and charter airline operations, respectively. Cargo airline destinations and flight patterns are largely maintained from 2017 observed operations. The 501 to 1000 nautical mile stage length segment will make up 71 percent of total cargo flights in the Future Planning Horizon. Charter airline operational data were derived from the U.S. Department of Transportation (DOT) database. Charter airline stage lengths are more evenly distributed than cargo flight stage lengths. Sixty percent of charter operations will be in the 1,000 nautical mile range.

Table E-16 Stage Length Assumptions, Cargo Operations, Future Planning Horizon[1]

Stage Length (nm)	Narrow-Body Jet	Wide-Body Jet	Non-Jet	Total	Percent of Total
0 to 500	434	1,302	0	1,736	24%
501 to 1000	868	4,339	0	5,207	71%
1001 to 1500	0	434	0	434	6%
1501 to 2500	0	0	0	0	0%
Total	**1,302**	**6,075**	**0**	**7,377**	**100%**

Source: Inter*VISTAS.*
Notes: Totals may not add exactly due to rounding.
nm – nautical miles
1 Represents the 10- to 15-year planning horizon.

Table E-17 Stage Length Assumptions, Charter Airline Operations, Future Planning Horizon[1]

Stage Length (nm)	NB ≤ 150	NB > 150	WB ≤ 240	WB > 240	Total	Percent of Total
0 to 500	102	51	0	0	154	34%
501 to 1000	73	48	0	0	121	26%
1001 to 1500	29	40	0	0	69	15%
1501 to 2500	29	44	0	0	73	16%
2501 to 3500	0	11	0	29	40	9%
Total	**234**	**194**	**0**	**29**	**457**	**100%**

Source: Inter*VISTAS.*
Notes: Totals may not add exactly due to rounding.
nm – nautical miles
1 Represents the 10- to 15-year planning horizon.

Table E-18 summarizes arrival and departure times of North American passenger, long-haul international passenger, cargo, charter, and GA flights organized by stage length. Nighttime hours are defined as 10:00 PM to 7:00 AM. The results presented here are based on the Future Planning Horizon average day, peak month flight schedule, which was developed from airline schedules for an average day in August 2017.

Table E-18 Time-of-Day Assumptions by User Category and Stage Length (Future Planning Horizon[1])

User Category	Stage Length (nm)	Arrivals Day	Arrivals Night	Departures Day	Departures Night
Sched Psgr - North America	0 to 500	93.4%	6.6%	91.6%	8.4%
Sched Psgr - North America	501 to 1,000	82.1%	17.9%	88.4%	11.6%
Sched Psgr - North America	1,001 to 1,500	82.5%	17.5%	86.6%	13.4%
Sched Psgr - North America	1,501 to 2,500	65.6%	34.4%	92.2%	7.8%
Sched Psgr - Long-Haul Int'l	1,501 to 2,500	100.0%	0.0%	80.0%	20.0%
Sched Psgr - Long-Haul Int'l	2,501 to 3,500	97.3%	2.7%	86.5%	13.5%
Sched Psgr - Long-Haul Int'l	3,501 to 4,500	100.0%	0.0%	33.3%	66.7%
Sched Psgr - Long-Haul Int'l	4,501 to 5,500	0.0%	100.0%	100.0%	0.0%
Sched Psgr - Long-Haul Int'l	5,501 to 6,500	100.0%	0.0%	83.3%	16.7%
Sched Psgr - Long-Haul Int'l	over 6,500	0.0%	100.0%	0.0%	100.0%
Cargo	0 to 500	33.3%	66.7%	25.0%	75.0%
Cargo	501 to 1,000	53.8%	46.2%	58.3%	41.7%
Cargo	1,001 to 1,500	100.0%	0.0%	100.0%	0.0%
Charter	0 to 500	91.2%	8.8%	88.7%	11.3%
Charter	501 to 1,000	82.5%	17.5%	86.8%	13.2%
Charter	1,001 to 1,500	87.9%	12.1%	98.1%	1.9%
Charter	2,501 to 3,500	56.7%	43.3%	98.0%	2.0%
General Aviation	0 to 500	92.7%	7.3%	92.5%	7.5%
General Aviation	501 to 1,000	100.0%	0.0%	75.0%	25.0%
General Aviation	1,001 to 1,500	100.0%	0.0%	100.0%	0.0%

Source: Inter*VISTAS*.
Notes: nm – nautical miles
1 Represents the 10- to 15-year planning horizon.

Peak Month, Busy Day Hourly Passenger Forecast

The peak passenger forecast reflects a busy weekday of the peak month at Logan Airport in terms of passenger numbers. The peak month is usually a summer month as more people travel due to summer vacations. In 2017, the peak month for passenger traffic was August, and the selected busy day was August 4, 2017. The percentage of O&D passengers was determined from U.S. Department of Transportation T-100 data for the month of August. Then the selected peak month peak day passenger numbers were compared to the average day peak month passenger numbers. The ratio of these two numbers was applied to the Future Planning Horizon forecast to predict peak month, busy day passengers.

Table E-19 shows the peak month busy day local passengers for domestic and international destinations. 2017 is actual data, the Future Planning Horizon is forecasted data. As shown, the portion of domestic local

passengers is 94.0 percent, and the portion of international local passengers is 89.4 percent. Busy day domestic passenger traffic is 2.4 percent higher than average day domestic traffic, and busy day international passenger traffic is 7.2 percent higher than average day international traffic in the peak month. Busy day local domestic passengers increase from 94,556 in 2017 to 129,542 in the future planning horizon. For international passengers, this number increases from 20,161 to 28,765.

Table E-19 Peak Month Busy Day Local Passengers, 2017 Base Year and Future Planning Horizon[1]

	2017 Domestic	2017 International	Future Planning Horizon Domestic	Future Planning Horizon International
Annual Enplaned + Deplaned Passengers	31,100,950	7,199,595	40,797,282	9,202,718
Percent Peak Month	9.6%	10.7%	9.6%	10.7%
Peak Month Enplaned + Deplaned Passengers	2,973,507	772,817	3,916,539	984,691
Percent Local	94.0%	89.4%	94.0%	89.4%
Peak Month Local Passengers	2,795,097	690,898	3,681,547	880,314
Peak Month, Average Day Local Passengers	92,304	18,803	126,457	26,827
Busy Day as a Percent of Average Day	102.4%	107.2%	102.4%	107.2%
Peak Month, Busy Day Local Passengers	**94,556**	**20,161**	**129,542**	**28,765**

Source: Massport and Inter*VISTAS*.
1 Represents the 10- to 15-year planning horizon.

Forecast busy day passengers are also distributed by terminal, as shown in **Table E-20**. The terminal distribution forecast for the Future Planning Horizon assumes the airline locations from a proposed Massport future gate allocation plan. According to this plan, Terminal A has 21 narrow-body equivalent gates, Terminal B has 37, and Terminal C has 27. The forecast also assumes that Terminal B will see more passenger traffic once planned renovations are complete.

Table E-20 Actual and Assumed Future Distribution of Passengers by Terminal

Terminal	Narrow-Body Equivalent Gates	Percent of Total	2017 Peak Month Passengers	Future Planning Horizon[1] Peak Month Passengers
A	21	24.7%	28.2%	27.7%
B	37	43.5%	37.2%	37.5%
C	27	31.8%	34.6%	34.8%
Total	**85**	**100%**	**100%**	**100%**

Source: Massport and Inter*VISTAS*.
1 Represents the 10- to 15-year planning horizon.

Actual and forecast local passengers by terminal for the peak month, busy day are shown in **Table E-21**. The forecast assumes that Southwest Airlines will move operations to Terminal B, Alaska Airlines (and Virgin America) will operate out of Terminal A, and Spirit Airlines will operate out of Terminal C. It is also assumed that Terminal E gates are used by airlines with limited frequency operations, such as Sun Country Airlines. Emirates and Aer Lingus are expected to move back from Terminal C to Terminal E, but other international departures by U.S. carriers will still occur in domestic terminals. Based on these assumptions, domestic passenger numbers are forecast to increase from 94,556 to 129,542, and international passengers are forecast to grow from 20,162 to 28,765 in the Future Planning Horizon.

Table E-21 Peak Month Busy Day Local Passengers by Terminal, 2017 Actual and Future Planning Horizon[1]

Terminal	2017 Domestic	2017 International	Future Planning Horizon Domestic	Future Planning Horizon International
A	27,060	1,629	35,482	2,746
B	35,839	2,025	49,814	2,395
C	31,657	2,124	44,246	2,877
E	0	14,384	0	20,747
Total Airport	**94,556**	**20,162**	**129,542**	**28,765**

Source: Inter*VISTAS*

1 Represents the 10- to 15-year planning horizon.

The hourly distribution of 2017 passengers by terminal is developed using published flight schedules, which provide departure and arrival times, seat counts, and airline assignments by terminal. The hourly distribution of passengers by terminal is shown for the busy day, peak month in 2017 in **Table E-22**.

Table E-22 Distribution of Passengers by Hour for a Busy Day of the Peak Month, 2017

	Terminal A		Terminal B		Terminal C		Terminal E		Total Airport		
Hour	**Arrive**	**Depart**	**Arrive**	**Depart**	**Arrive**	**Depart**	**Arrive**	**Depart**	**Arrive**	**Depart**	**Total**
00:00-00:59	2.6%	0.0%	6.2%	0.0%	3.1%	0.0%	0.0%	0.0%	3.5%	0.0%	1.8%
01:00-01:59	3.2%	0.0%	0.7%	0.0%	0.0%	0.0%	0.0%	3.6%	1.0%	0.4%	0.7%
02:00-02:59	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
03:00-03:59	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
04:00-04:59	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
05:00-05:59	3.1%	7.1%	1.4%	5.9%	3.7%	2.2%	0.0%	0.0%	2.3%	4.4%	3.4%
06:00-06:59	1.0%	6.1%	0.8%	11.3%	4.3%	7.3%	0.0%	0.7%	1.8%	7.6%	4.7%
07:00-07:59	1.3%	9.2%	3.8%	4.3%	7.4%	11.3%	3.1%	2.7%	4.2%	7.5%	5.8%
08:00-08:59	3.1%	4.7%	3.9%	7.8%	1.8%	7.4%	0.0%	0.0%	2.6%	6.0%	4.3%
09:00-09:59	4.1%	3.8%	4.0%	6.1%	5.8%	4.8%	0.0%	2.6%	4.0%	4.7%	4.4%
10:00-10:59	6.5%	5.4%	5.4%	6.5%	3.8%	5.1%	0.6%	0.0%	4.5%	5.0%	4.8%
11:00-11:59	3.5%	6.0%	5.2%	3.6%	2.1%	5.8%	0.0%	0.7%	3.1%	4.6%	3.8%
12:00-12:59	3.8%	4.0%	4.6%	7.7%	3.1%	2.8%	10.9%	0.0%	4.8%	4.4%	4.6%
13:00-13:59	8.4%	2.7%	4.4%	4.3%	5.7%	2.3%	6.8%	3.0%	6.1%	3.1%	4.6%
14:00-14:59	6.9%	8.1%	4.2%	5.0%	4.2%	3.5%	8.4%	2.1%	5.4%	5.0%	5.2%
15:00-15:59	5.8%	4.3%	6.4%	4.5%	7.0%	4.0%	11.5%	0.7%	7.1%	3.9%	5.5%
16:00-16:59	5.6%	8.4%	6.6%	7.0%	8.9%	9.4%	6.1%	0.0%	7.0%	7.3%	7.1%
17:00-17:59	8.4%	8.7%	10.3%	5.6%	5.4%	6.4%	8.3%	18.3%	8.1%	8.1%	8.1%
18:00-18:59	4.9%	7.3%	4.7%	10.0%	6.2%	7.5%	11.9%	2.4%	6.2%	7.7%	6.9%
19:00-19:59	7.2%	10.6%	4.4%	5.4%	6.5%	7.5%	17.3%	12.3%	7.5%	8.2%	7.8%
20:00-20:59	4.0%	1.8%	5.9%	2.5%	6.5%	4.4%	7.0%	6.1%	5.8%	3.3%	4.5%
21:00-21:59	4.5%	1.9%	6.8%	2.5%	3.4%	6.1%	4.2%	20.8%	4.9%	5.5%	5.2%
22:00-22:59	5.8%	0.0%	5.4%	0.0%	4.4%	1.4%	3.8%	11.7%	5.0%	1.8%	3.4%
23:00-23:59	6.2%	0.0%	4.9%	0.0%	6.9%	0.7%	0.0%	12.2%	5.1%	1.6%	3.4%
Peak Percent	**8.4%**	**10.6%**	**10.3%**	**11.3%**	**8.9%**	**11.3%**	**17.3%**	**20.8%**	**8.1%**	**8.2%**	**8.1%**
Peak Hour	**17:00-17:59**	**19:00-19:59**	**17:00-17:59**	**06:00-06:59**	**16:00-16:59**	**07:00-07:59**	**19:00-19:59**	**21:00-21:59**	**17:00-17:59**	**19:00-19:59**	**17:00-17:59**

Source: Massport and Inter*VISTAS*

Table E-23 provides an overview of hourly distribution forecast of terminal passengers for a busy day of the peak month for the Future Planning Horizon. For the forecast, the ratios between the average day, peak month and the busy day, peak month in 2017 were applied to create a passenger distribution for the busy day, peak month for the Future Planning Horizon. The flight schedules were grown based on these ratios, and gate assignments were adjusted based on expected airline terminal relocations, as explained earlier.

Table E-23 Assumed Distribution of Terminal Passengers by Hour for a Busy Day of the Peak Month, Future Planning Horizon[1]

	Terminals A, B, and C		Terminal E	
Hour	**Arrive**	**Depart**	**Arrive**	**Depart**
00:00-00:59	2.8%	0.0%	0.0%	1.0%
01:00-01:59	1.5%	0.0%	0.0%	2.3%
02:00-02:59	0.0%	0.0%	0.0%	0.0%
03:00-03:59	0.0%	0.0%	0.0%	0.0%
04:00-04:59	0.0%	0.0%	0.0%	0.0%
05:00-05:59	1.3%	2.8%	1.8%	0.0%
06:00-06:59	2.4%	7.5%	0.0%	0.5%
07:00-07:59	3.5%	8.9%	2.1%	1.7%
08:00-08:59	4.9%	6.2%	0.0%	0.0%
09:00-09:59	4.4%	7.7%	1.6%	1.5%
10:00-10:59	5.0%	5.5%	1.5%	0.0%
11:00-11:59	5.3%	5.2%	1.9%	0.0%
12:00-12:59	4.3%	5.9%	7.2%	0.5%
13:00-13:59	5.8%	3.5%	13.3%	3.8%
14:00-14:59	5.6%	5.9%	11.0%	1.5%
15:00-15:59	6.8%	5.5%	7.3%	1.6%
16:00-16:59	6.8%	7.0%	10.8%	3.1%
17:00-17:59	7.1%	6.8%	6.1%	12.6%
18:00-18:59	4.8%	6.9%	12.6%	14.5%
19:00-19:59	6.0%	7.5%	9.4%	10.7%
20:00-20:59	5.3%	4.6%	5.8%	4.3%
21:00-21:59	6.0%	1.7%	4.2%	21.5%
22:00-22:59	5.8%	0.5%	3.4%	8.6%
23:00-23:59	4.8%	0.3%	0.0%	10.1%
Peak Percent	**7.1%**	**8.9%**	**13.3%**	**21.5%**
Peak Hour	**17:00-17:59**	**07:00-07:59**	**13:00-13:59**	**21:00-21:59**

Source: Massport and Inter*VISTAS*
Notes: Gate assignments planned for the Future Planning Horizon (based on Massport assumptions for 2021).
1 Represents the 10- to 15-year planning horizon.

Arriving and departing passengers by terminal and hour of the day in 2017 are shown in **Table E-24**. In 2017, Terminal B was the busiest terminal with nearly 40,000 local passengers. Terminal C was the second busiest with over 37,000 passengers, followed by Terminal A with over 30,000 passengers. Terminal E handled close to 16,000 local passengers.

Table E-24 Peak Month Busy Day Passengers by Terminal and by Hour, 2017

	Terminal A		Terminal B		Terminal C		Terminal E		Total Airport		
Hour	**Arrive**	**Depart**	**Arrive**	**Depart**	**Arrive**	**Depart**	**Arrive**	**Depart**	**Arrive**	**Depart**	**Total**
00:00-00:59	390	-	1,225	-	568	-	-	-	2,182	-	2,182
01:00-01:59	477	-	146	-	-	-	-	255	623	255	879
02:00-02:59	-	-	-	-	-	-	-	-	-	-	-
03:00-03:59	-	-	-	-	-	-	-	-	-	-	-
04:00-04:59	-	-	-	-	-	-	-	-	-	-	-
05:00-05:59	453	1,110	286	1,185	680	418	-	-	1,420	2,713	4,133
06:00-06:59	143	954	161	2,270	785	1,391	-	51	1,089	4,666	5,755
07:00-07:59	190	1,428	752	857	1,353	2,145	269	188	2,564	4,618	7,182
08:00-08:59	462	737	779	1,559	331	1,392	-	-	1,572	3,688	5,260
09:00-09:59	606	591	798	1,233	1,049	906	-	183	2,454	2,914	5,367
10:00-10:59	960	834	1,071	1,305	685	957	51	-	2,767	3,096	5,862
11:00-11:59	522	941	1,023	719	379	1,102	-	51	1,924	2,812	4,736
12:00-12:59	557	622	905	1,554	567	525	955	-	2,983	2,702	5,685
13:00-13:59	1,236	413	871	857	1,036	434	598	213	3,741	1,918	5,659
14:00-14:59	1,014	1,260	828	998	762	665	738	152	3,342	3,075	6,417
15:00-15:59	850	672	1,264	912	1,269	759	1,009	51	4,392	2,395	6,786
16:00-16:59	826	1,302	1,304	1,410	1,613	1,787	538	-	4,281	4,499	8,780
17:00-17:59	1,240	1,348	2,032	1,132	977	1,218	728	1,290	**4,977**	4,989	**9,967**
18:00-18:59	721	1,135	931	2,013	1,122	1,430	1,042	168	3,814	4,746	8,560
19:00-19:59	1,055	1,648	862	1,084	1,184	1,425	1,517	871	4,619	**5,028**	9,647
20:00-20:59	595	276	1,174	501	1,179	828	613	430	3,561	2,034	5,595
21:00-21:59	659	291	1,354	500	620	1,156	370	1,471	3,004	3,419	6,423
22:00-22:59	849	-	1,067	-	807	269	335	829	3,057	1,098	4,156
23:00-23:59	915	-	975	-	1,256	134	-	864	3,145	998	4,143
Total	**14,717**	**15,565**	**19,808**	**20,088**	**18,223**	**18,942**	**8,763**	**7,068**	**61,511**	**61,662**	**123,173**

Source: Massport and Inter*VISTAS*
Notes: Bold indicates airport-wide peak hour passengers.

Table E-25 shows a similar peak month, busy day passenger distribution by terminal and time of day for the forecast year. Terminal B is expected to remain the busiest terminal with nearly 55,000 local passengers, followed by Terminal C with over 49,000 passengers. Terminal A is forecast to process over 39,000 passengers, and Terminal E is forecast to process over 26,000 local passengers in the Future Planning Horizon.

Table E-25	Peak Month Busy Day Passengers by Terminal and by Hour, Future Planning Horizon[1]										
	Terminal A		**Terminal B**		**Terminal C**		**Terminal E**		**Total Airport**		
Hour	**Arrive**	**Depart**	**Arrive**	**Depart**	**Arrive**	**Depart**	**Arrive**	**Depart**	**Arrive**	**Depart**	**Total**
00:00-00:59	799	-	1,064	-	131	-	-	117	1,994	117	2,111
01:00-01:59	-	-	884	-	179	-	-	277	1,063	277	1,339
02:00-02:59	-	-	-	-	-	-	-	-	-	-	-
03:00-03:59	-	-	-	-	-	-	-	-	-	-	-
04:00-04:59	-	-	-	-	-	-	-	-	-	-	-
05:00-05:59	300	296	148	1,248	462	488	257	-	1,166	2,032	3,198
06:00-06:59	614	1,208	-	2,108	1,054	2,177	-	63	1,668	5,556	7,224
07:00-07:59	880	2,505	829	1,856	733	2,144	298	206	2,740	6,711	9,451
08:00-08:59	704	1,088	1,256	2,070	1,471	1,420	-	-	3,432	4,579	8,011
09:00-09:59	856	1,534	1,108	1,874	1,131	2,219	225	179	3,320	5,806	9,126
10:00-10:59	918	782	1,252	1,544	1,329	1,707	219	-	3,718	4,033	7,751
11:00-11:59	1,063	1,104	1,885	1,229	806	1,503	277	-	4,031	3,836	7,867
12:00-12:59	748	921	1,259	2,267	1,047	1,137	1,035	63	4,089	4,388	8,476
13:00-13:59	972	670	1,519	882	1,600	1,016	1,918	453	6,010	3,021	9,031
14:00-14:59	1,515	1,626	1,170	1,507	1,251	1,168	1,583	177	5,520	4,478	9,998
15:00-15:59	1,311	1,086	1,875	1,614	1,615	1,355	1,045	189	5,846	4,244	10,089
16:00-16:59	1,599	1,279	1,970	2,330	1,207	1,526	1,559	371	**6,336**	5,507	11,842
17:00-17:59	1,403	2,064	2,077	1,796	1,507	1,137	880	1,488	5,867	6,485	12,352
18:00-18:59	699	1,171	1,292	1,955	1,421	1,902	1,821	1,714	5,233	6,742	11,975
19:00-19:59	1,099	1,943	1,770	1,469	1,377	2,125	1,357	1,257	5,602	**6,794**	**12,396**
20:00-20:59	751	602	1,565	1,207	1,435	1,576	837	508	4,589	3,893	8,481
21:00-21:59	966	462	2,014	238	1,234	573	607	2,535	4,821	3,807	8,628
22:00-22:59	1,250	-	859	254	1,954	141	483	1,010	4,546	1,406	5,951
23:00-23:59	753	-	1,659	-	966	183	-	1,194	3,378	1,377	4,754
Total	**19,200**	**20,342**	**27,455**	**27,448**	**23,910**	**25,496**	**14,402**	**11,800**	**84,967**	**85,087**	**170,053**

Source: Massport and InterVISTAS

Notes: Gate assignments planned for the Future Planning Horizon (based on Massport assumptions for 2021). Bold indicates airport-wide peak hour passengers.

1 Represents the 10- to 15-year planning horizon.

Conclusion

Passenger demand continues to grow at Logan Airport and it is forecast to increase from over 38 million scheduled and charter passengers in 2017 to 50 million passengers in the Future Planning Horizon, translating to a 1.5-percent compound annual growth rate. Passenger aircraft operations are expected to increase at a lower average annual rate of 1.2 percent, increasing from over 363,000 to over 447,000. Average passenger throughput is expected to increase from 104 passengers per operation in 2017 to 117 passengers per operation in the Future Planning Horizon. This discrepancy between passenger and operations growth rate will be the result of airlines flying larger aircraft and operating aircraft with larger seat capacities. New aircraft types will be entering service (e.g. Boeing 737 MAX, Airbus 320 NEO family) that will open new market opportunities besides replacing older, aging aircraft. The 50-seat RJ market is expected to shrink as more carriers shift operations to larger, 76- to 90-seat, aircraft (e.g. Embraer 175/195). Long-haul operations will continue to grow with Europe remaining the most mature international market, but Central and South America growing the fastest.

F

Regional Transportation

This appendix provides detailed tables in support of Chapter 4, *Regional Transportation*:

- Table F-1 Aircraft Operations by Classification for New England's Airports, 2000 to 2017
- Table F-2 Percentage Change in Aircraft Operations by Classification for New England's Airports, 2000 to 2017

Scheduled Passenger Operations by Market and Carrier for New England's Regional Airports

- Table F-3 Scheduled Passenger Operations by Market and Carrier for Bradley International Airport
- Table F-4 Scheduled Passenger Operations by Market and Carrier for T.F. Green Airport
- Table F-5 Scheduled Passenger Operations by Market and Carrier for Manchester-Boston Regional Airport
- Table F-6 Scheduled Passenger Operations by Market and Carrier for Portland International Jetport
- Table F-7 Scheduled Passenger Operations by Market and Carrier for Burlington International Airport
- Table F-8 Scheduled Passenger Operations by Market and Carrier for Bangor International Airport
- Table F-9 Scheduled Passenger Operations by Market and Carrier for Tweed-New Haven Airport
- Table F-10 Scheduled Passenger Operations by Market and Carrier for Worcester Regional Airport
- Table F-11 Scheduled Passenger Operations by Market and Carrier for Hanscom Field
- Table F-12 Scheduled Passenger Operations by Market and Carrier for Portsmouth International Airport

This Page Intentionally Left Blank.

Table F-1 Aircraft Operations by Classification for New England's Airports, 2000 to 2017

Airport	Bradley International	T.F. Green	Manchester-Boston Regional	Portland International Jetport	Burlington	Bangor	Tweed-New Haven	Worcester Regional	Portsmouth International	Hanscom Field[2]	Subtotal	Logan[3]	Total
2000													
Commercial	132,062	103,750	61,506	47,609	45,745	21,446	5,260	4,029	6,104	6,572	434,083	452,763	886,846
General Aviation[1]	31,863	52,184	45,740	56,571	59,377	34,831	56,200	46,518	31,601	204,512	619,397	35,233	654,630
Military & Other	5,811	2,764	586	2,072	10,241	26,507	328	495	9,973	1,287	60,064	0	60,064
Total	**169,736**	**158,698**	**107,832**	**106,252**	**115,363**	**82,784**	**61,788**	**51,042**	**47,678**	**212,371**	**1,113,544**	**487,996**	**1,601,540**
2001													
Commercial	128,638	100,606	61,669	47,770	47,261	18,286	4,581	5,631	4,485	6,414	425,341	434,386	859,727
General Aviation[1]	30,478	45,095	44,358	62,014	61,986	35,230	56,092	45,464	30,148	197,770	608,635	28,739	637,374
Military & Other	5,913	2,635	607	2,259	11,821	26,623	437	917	8,221	1,252	60,685	0	60,685
Total	**165,029**	**148,336**	**106,634**	**112,043**	**121,068**	**80,139**	**61,110**	**52,012**	**42,854**	**205,436**	**1,094,661**	**463,125**	**1,557,786**
2002													
Commercial	113,194	96,595	62,346	45,899	38,929	24,412	3,827	4,062	5,059	6,603	400,926	366,476	767,402
General Aviation[1]	27,838	45,473	29,549	57,720	59,679	35,711	62,163	52,277	28,333	210,221	608,964	25,596	634,560
Military & Other	6,085	2,587	376	2,162	12,167	27,297	593	418	8,220	1,424	61,329	0	61,329
Total	**147,117**	**144,655**	**92,271**	**105,781**	**110,775**	**87,420**	**66,583**	**56,757**	**41,612**	**218,248**	**1,071,219**	**392,072**	**1,463,291**
2003													
Commercial	103,917	84,301	68,184	42,658	38,293	25,626	3,705	868	4,552	2,956	375,060	344,644	719,704
General Aviation[1]	27,115	42,878	29,552	44,036	50,461	36,706	54,224	55,972	24,866	190,789	556,599	28,660	585,259
Military & Other	4,214	2,496	324	1,449	11,466	32,938	776	378	7,720	1,142	62,903	0	62,903
Total	**135,246**	**129,675**	**98,060**	**88,143**	**100,220**	**95,270**	**58,705**	**57,218**	**37,138**	**194,887**	**994,562**	**373,304**	**1,367,866**
2004													
Commercial	108,823	83,496	75,360	46,474	41,719	24,970	4,501	0	3,981	4,308	393,632	374,022	767,654
General Aviation[1]	32,269	34,878	27,438	41,547	54,709	29,884	58,881	61,343	25,962	175,301	542,212	31,236	573,448
Military & Other	4,100	346	749	1,338	12,404	29,676	1,010	530	7,797	1,195	59,145	0	59,145
Total	**145,192**	**118,720**	**103,547**	**89,359**	**108,832**	**84,530**	**64,392**	**61,873**	**37,740**	**180,804**	**994,989**	**405,258**	**1,400,247**

Table F-1 Aircraft Operations by Classification for New England's Airports, 2000 to 2017 (Continued)

Airport	Bradley International	T.F. Green	Manchester-Boston Regional	Portland International Jetport	Burlington	Bangor	Tweed-New Haven	Worcester Regional	Portsmouth International	Hanscom Field[2]	Subtotal	Logan[3]	Total
2005													
Commercial	119,048	88,374	76,342	42,661	43,987	25,976	6,137	2,727	3,197	3,627	412,076	377,830	789,906
General Aviation[1]	33,341	28,138	26,369	36,191	49,888	30,016	60,893	62,743	25,446	165,424	518,449	31,236	549,685
Military & Other	3,701	241	479	1,405	11,468	24,154	1,063	519	7,669	904	51,603	0	51,603
Total	**156,090**	**116,753**	**103,190**	**80,257**	**105,343**	**80,146**	**68,093**	**65,989**	**36,312**	**169,955**	**982,128**	**409,066**	**1,391,194**
2006													
Commercial	111,341	81,282	67,326	38,663	41,342	23,466	5,177	3,793	3,981	3,057	379,428	374,675	754,103
General Aviation[1]	34,548	25,510	25,074	35,572	44,471	29,848	51,702	56,770	25,962	167,560	497,017	31,444	528,461
Military & Other	4,348	229	738	1,536	9,299	22,359	1,157	609	7,797	1,433	49,505	0	49,505
Total	**150,237**	**107,021**	**93,138**	**75,771**	**95,112**	**75,673**	**58,036**	**61,172**	**37,740**	**172,050**	**925,950**	**406,119**	**1,332,069**
2007													
Commercial	107,097	80,525	69,134	41,450	39,928	22,571	4,594	3,162	4,270	3,477	376,208	370,905	747,113
General Aviation[1]	29,308	22,984	23,959	31,724	47,521	25,542	51,200	61,296	27,000	160,992	481,526	28,632	510,158
Military & Other	5,097	242	644	1,384	9,528	20,949	944	879	8,017	1,438	49,122	0	49,122
Total	**141,502**	**103,751**	**93,737**	**74,558**	**96,977**	**69,062**	**56,738**	**65,337**	**39,287**	**165,907**	**906,856**	**399,537**	**1,306,393**
2008													
Commercial	98,194	73,096	63,505	40,834	37,832	19,282	4,013	2,553	1,347	104	340,760	347,784	688,544
General Aviation[1]	22,908	19,470	16,198	31,869	46,391	27,143	44,642	43,763	31,051	164,195	447,630	23,820	471,450
Military & Other	3,637	187	840	974	9,688	20,449	243	886	7,993	1,590	46,487	0	46,487
Total	**124,739**	**92,753**	**80,543**	**73,677**	**93,911**	**66,874**	**48,898**	**47,202**	**40,391**	**165,889**	**834,877**	**371,604**	**1,206,481**
2009													
Commercial	82,021	62,233	54,336	35,909	31,153	16,485	3,096	2,527	422	0	288,182	333,064	621,246
General Aviation[1]	19,586	19,438	14,354	25,473	32,872	19,558	37,722	41,700	25,161	148,696	384,560	12,242	396,802
Military & Other	2,726	260	1,163	778	8,628	16,267	486	17	6,851	1,215	38,391	0	38,391
Total	**104,333**	**81,931**	**69,853**	**62,160**	**72,653**	**52,310**	**41,304**	**44,244**	**32,434**	**149,911**	**711,133**	**345,306**	**1,056,439**

Table F-1 Aircraft Operations by Classification for New England's Airports, 2000 to 2017 (Continued)

Airport	Bradley International	T.F. Green	Manchester-Boston Regional	Portland International Jetport	Burlington	Bangor	Tweed-New Haven	Worcester Regional	Portsmouth International	Hanscom Field[2]	Subtotal	Logan[3]	Total
2010													
Commercial	80,418	60,128	53,971	35,035	29,538	16,190	3,201	1,629	1,516	0	281,626	337,961	619,587
General Aviation[1]	18,759	21,096	13,636	24,776	36,106	20,142	31,884	41,843	25,674	161,942	395,858	14,682	410,540
Military & Other	3,028	347	933	446	4,776	15,525	381	572	7,707	1,795	35,510	0	35,510
Total	**102,205**	**81,571**	**68,540**	**60,257**	**70,420**	**51,857**	**35,466**	**44,044**	**34,897**	**163,737**	**712,994**	**352,643**	**1,065,637**
2011													
Commercial	86,838	57,194	51,379	35,157	29,166	16,177	3,367	2,017	1,717	750	283,762	340,757	624,519
General Aviation[1]	16,483	21,774	12,497	21,453	42,562	19,503	33,919	44,050	27,056	160,840	400,137	28,230	428,367
Military & Other	3,630	369	874	533	5,890	13,220	310	634	8,158	1,409	35,027	0	35,027
Total	**106,951**	**79,337**	**64,750**	**57,143**	**77,618**	**48,900**	**37,596**	**46,701**	**36,931**	**162,999**	**718,926**	**368,987**	**1,087,913**
2012													
Commercial	79,704	50,301	45,379	33,118	27,067	14,826	3,936	1,639	502	635	257,107	326,755	583,862
General Aviation[1]	15,589	24,781	12,504	20,864	42,352	18,069	34,775	42,655	30,186	164,841	406,616	28,114	434,730
Military & Other	3,726	434	1,073	584	7,079	11,503	416	740	7,917	738	34,210	0	34,210
Total	**99,019**	**75,516**	**58,956**	**54,566**	**76,498**	**44,398**	**39,127**	**45,034**	**38,605**	**166,214**	**697,933**	**354,869**	**1,052,802**
2013													
Commercial	78,213	48,340	43,572	31,076	26,814	14,707	4,094	1,586	560	253	249,215	334,657	583,872
General Aviation[1]	15,192	24,729	11,432	20,021	40,413	15,535	28,794	32,888	28,951	153,706	371,661	26,682	398,343
Military & Other	2,558	435	1,224	471	6,972	11,045	423	593	7,573	529	31,823	0	31,823
Total	**95,963**	**73,504**	**56,228**	**51,568**	**74,199**	**41,287**	**33,311**	**35,067**	**37,084**	**154,488**	**652,699**	**361,339**	**1,014,038**
2014													
Commercial	79,060	44,351	38,674	29,538	26,057	14,428	4,795	2,368	8,278	256	247,805	337,381	585,186
General Aviation[1]	14,752	29,490	12,293	16,535	40,858	15,548	26,273	29,138	24,440	133,437	342,764	26,416	369,180
Military & Other	2,665	1,036	908	560	6,842	11,567	529	956	7,621	602	33,286	0	33,286
Total	**96,477**	**74,877**	**51,875**	**46,633**	**73,757**	**41,543**	**31,597**	**32,462**	**40,339**	**134,295**	**623,855**	**363,797**	**987,652**

Table F-1 Aircraft Operations by Classification for New England's Airports, 2000 to 2017 (Continued)

Airport	Bradley International	T.F. Green	Manchester-Boston Regional	Portland International Jetport	Burlington	Bangor	Tweed-New Haven	Worcester Regional	Portsmouth International	Hanscom Field[2]	Subtotal	Logan[3]	Total
2015													
Commercial	76,425	42,417	38,060	30,415	25,178	13,618	6,316	2,414	8,547	220	243,610	344,764	588,374
General Aviation[1]	14,402	22,700	12,934	17,916	41,576	16,487	27,711	35,711	26,848	127,467	343,752	28,166	371,918
Military & Other	2,680	430	811	567	5,912	10,684	685	889	7,499	592	30,749	0	30,749
Total	**93,507**	**65,547**	**51,805**	**48,898**	**72,666**	**40,789**	**34,712**	**39,014**	**42,894**	**128,279**	**618,111**	**372,930**	**991,041**
2016													
Commercial	77,174	43,659	40,589	32,171	26,405	14,603	7,195	2,616	9,435	266	254,113	360,442	614,555
General Aviation[1]	14,460	26,032	14,447	18,334	38,614	16,815	28,811	31,858	29,043	120,891	339,305	30,780	370,085
Military & Other	3,178	397	501	488	6,114	11,271	683	780	8,913	632	32,957	0	32,957
Total	**94,812**	**70,088**	**55,537**	**50,993**	**71,133**	**42,689**	**36,689**	**35,254**	**47,391**	**121,789**	**626,375**	**391,222**	**1,017,597**
2017													
Commercial	78,435	45,831	37,850	32,845	26,684	15,874	6,820	2,925	9,597	295	257,156	370,251	627,407
General Aviation[1]	13,233	26,274	13,169	18,392	34,386	17,157	18,389	26,332	31,555	128,018	326,905	31,120	358,025
Military & Other	3,006	490	697	568	5,080	9,985	574	850	8,150	759	30,159	0	30,159
Total	**94,674**	**72,595**	**51,716**	**51,805**	**66,150**	**43,016**	**25,783**	**30,107**	**49,302**	**129,072**	**614,220**	**401,371**	**1,015,591**

Source: Massport, Federal Aviation Administration (FAA) Tower Counts, and individual airport records.

1 Includes itinerant and local general aviation operations at the regional airports. There are no local (touch-and-go training) operations at Logan Airport.

2 Commercial operations at Hanscom Field include scheduled commercial operations only; other air taxi operations counted as GA.

3 Operations at Logan Airport include international operations.

Table F-2 Percentage Change in Aircraft Operations by Classification for New England's Airports, 2000 to 2017

Airport	Bradley International	T.F. Green	Manchester-Boston Regional	Portland International Jetport	Burlington	Bangor	Tweed-New Haven	Worcester Regional	Portsmouth International	Hanscom Field[2]	Subtotal	Logan[3]	Total
2000 to 2001													
Commercial	(2.59%)	(3.03%)	0.27%	0.34%	3.31%	(14.73%)	(12.91%)	39.76%	(26.52%)	(2.40%)	(2.01%)	(4.06%)	(3.06%)
General Aviation[1]	(4.35%)	(13.58%)	(3.02%)	9.62%	4.39%	1.15%	(0.19%)	(2.27%)	(4.60%)	(3.30%)	(1.74%)	(18.43%)	(2.64%)
Military & Other	1.76%	(4.67%)	3.58%	9.03%	15.43%	0.44%	33.23%	85.25%	(17.57%)	(2.72%)	1.03%	-	1.03%
Total	**(2.77%)**	**(6.53%)**	**(1.11%)**	**5.45%**	**4.95%**	**(3.20%)**	**(1.10%)**	**1.90%**	**(10.12%)**	**(3.27%)**	**(1.70%)**	**(5.10%)**	**(2.73%)**
2001 Percent of Total	**10.59%**	**9.52%**	**6.85%**	**7.19%**	**7.77%**	**5.14%**	**3.92%**	**3.34%**	**2.75%**	**13.19%**	**70.27%**	**29.73%**	**100.00%**
2001 to 2002													
Commercial	(12.01%)	(3.99%)	1.10%	(3.92%)	(17.63%)	33.50%	(16.46%)	(27.86%)	12.80%	2.95%	(5.74%)	(15.63%)	(10.74%)
General Aviation[1]	(8.66%)	0.84%	(33.39%)	(6.92%)	(3.72%)	1.37%	10.82%	14.99%	(6.02%)	6.30%	0.05%	(10.94%)	(0.44%)
Military & Other	2.91%	(1.82%)	(38.06%)	(4.29%)	2.93%	2.53%	35.70%	(54.42%)	(0.01%)	13.74%	1.06%	-	1.06%
Total	**(10.85%)**	**(2.48%)**	**(13.47%)**	**(5.59%)**	**(8.50%)**	**9.09%**	**8.96%**	**9.12%**	**(2.90%)**	**6.24%**	**(2.14%)**	**(15.34%)**	**(6.07%)**
2002 Percent of Total	**10.05%**	**9.89%**	**6.31%**	**7.23%**	**7.57%**	**5.97%**	**4.55%**	**3.88%**	**2.84%**	**14.91%**	**73.21%**	**26.79%**	**100.00%**
2002 to 2003													
Commercial	(8.20%)	(12.73%)	9.36%	(7.06%)	(1.63%)	4.97%	(3.19%)	(78.63%)	(10.02%)	(55.23%)	(6.45%)	(5.96%)	(6.22%)
General Aviation[1]	(2.60%)	(5.71%)	0.01%	(23.71%)	(15.45%)	2.79%	(12.77%)	7.07%	(12.24%)	(9.24%)	(8.60%)	11.97%	(7.77%)
Military & Other	(30.75%)	(3.52%)	(13.83%)	(32.98%)	(5.76%)	20.67%	30.86%	(9.57%)	(6.08%)	(19.80%)	2.57%	-	2.57%
Total	**(8.07%)**	**(10.36%)**	**6.27%**	**(16.67%)**	**(9.53%)**	**8.98%**	**(11.83%)**	**0.81%**	**(10.75%)**	**(10.70%)**	**(7.16%)**	**(4.79%)**	**(6.52%)**
2003 Percent of Total	**9.89%**	**9.48%**	**7.17%**	**6.44%**	**7.33%**	**6.96%**	**4.29%**	**4.18%**	**2.72%**	**14.25%**	**72.71%**	**27.29%**	**100.00%**
2003 to 2004													
Commercial	4.72%	(0.95%)	10.52%	8.95%	8.95%	(2.56%)	21.48%	(100.00%)	(12.54%)	45.74%	4.95%	8.52%	6.66%
General Aviation[1]	19.01%	(18.66%)	(7.15%)	(5.65%)	8.42%	(18.59%)	8.59%	9.60%	4.41%	(8.12%)	(2.58%)	8.99%	(2.02%)
Military & Other	(2.71%)	(86.14%)	131.17%	(7.66%)	8.18%	(9.90%)	30.15%	40.21%	1.00%	4.64%	(5.97%)	-	(5.97%)
Total	**7.35%**	**(8.45%)**	**5.60%**	**1.38%**	**8.59%**	**(11.27%)**	**9.69%**	**8.14%**	**1.62%**	**(7.23%)**	**0.04%**	**8.56%**	**2.37%**
2004 Percent of Total	**10.37%**	**8.48%**	**7.39%**	**6.38%**	**7.77%**	**6.04%**	**4.60%**	**4.42%**	**2.70%**	**12.91%**	**71.06%**	**28.94%**	**100.00%**

Table F-2 Percentage Change in Aircraft Operations by Classification for New England's Airports, 2000 to 2017 (Continued)

Airport	Bradley International	T.F. Green	Manchester-Boston Regional	Portland International Jetport	Burlington	Bangor	Tweed-New Haven	Worcester Regional	Portsmouth International	Hanscom Field[2]	Subtotal	Logan[3]	Total
2004 to 2005													
Commercial	9.40%	5.84%	1.30%	(8.20%)	5.44%	4.03%	36.35%	-	(19.69%)	(15.81%)	4.69%	1.02%	2.90%
General Aviation[1]	3.32%	(19.32%)	(3.90%)	(12.89%)	(8.81%)	0.44%	3.42%	2.28%	(1.99%)	(5.63%)	(4.38%)	0.00%	(4.14%)
Military & Other	(9.73%)	(30.35%)	(36.05%)	5.01%	(7.55%)	(18.61%)	5.25%	(2.08%)	(1.64%)	(24.35%)	(12.75%)	-	(12.75%)
Total	**7.51%**	**(1.66%)**	**(0.34%)**	**(10.19%)**	**(3.21%)**	**(5.19%)**	**5.75%**	**6.65%**	**(3.78%)**	**(6.00%)**	**(1.29%)**	**0.94%**	**(0.65%)**
2005 Percent of Total	**11.22%**	**8.39%**	**7.42%**	**5.77%**	**7.57%**	**5.76%**	**4.89%**	**4.74%**	**2.61%**	**12.22%**	**70.60%**	**29.40%**	**100.00%**
2005 to 2006													
Commercial	(6.47%)	(8.02%)	(11.81%)	(9.37%)	(6.01%)	(9.66%)	(15.64%)	39.09%	24.52%	(15.72%)	(7.92%)	(0.84%)	(4.53%)
General Aviation1	3.62%	(9.34%)	(4.91%)	(1.71%)	(10.86%)	(0.56%)	(15.09%)	(9.52%)	2.03%	1.29%	(4.13%)	0.67%	(3.86%)
Military & Other	17.48%	(4.98%)	54.07%	9.32%	(18.91%)	(7.43%)	8.84%	17.34%	1.67%	58.52%	(4.07%)	-	(4.07%)
Total	**(3.75%)**	**(8.34%)**	**(9.74%)**	**(5.59%)**	**(9.71%)**	**(5.58%)**	**(14.77%)**	**(7.30%)**	**3.93%**	**1.23%**	**(5.72%)**	**(0.72%)**	**(4.25%)**
2006 Percent of Total	**11.28%**	**8.03%**	**6.99%**	**5.69%**	**7.14%**	**5.68%**	**4.36%**	**4.59%**	**2.83%**	**12.92%**	**69.51%**	**30.49%**	**100.00%**
2006 to 2007													
Commercial	(3.81%)	(0.93%)	2.69%	7.21%	(3.42%)	(3.81%)	(11.26%)	(16.64%)	7.26%	13.74%	(0.85%)	(1.01%)	(0.93%)
General Aviation1	(15.17%)	(9.90%)	(4.45%)	(10.82%)	6.86%	(14.43%)	(0.97%)	7.97%	4.00%	(3.92%)	(3.12%)	(8.94%)	(3.46%)
Military & Other	17.23%	5.68%	(12.74%)	(9.90%)	2.46%	(6.31%)	(18.41%)	44.33%	2.82%	0.35%	(0.77%)	-	(0.77%)
Total	**(5.81%)**	**(3.06%)**	**0.64%**	**(1.60%)**	**1.96%**	**(8.74%)**	**(2.24%)**	**6.81%**	**4.10%**	**(3.57%)**	**(2.06%)**	**(1.62%)**	**(1.93%)**
2007 Percent of Total	**10.83%**	**7.94%**	**7.18%**	**5.71%**	**7.42%**	**5.29%**	**4.34%**	**5.00%**	**3.01%**	**12.70%**	**69.42%**	**30.58%**	**100.00%**
2007 to 2008													
Commercial	(8.31%)	(9.23%)	(8.14%)	(1.49%)	(5.25%)	(14.57%)	(12.65%)	(19.26%)	(68.45%)	(97.01%)	(9.42%)	(6.23%)	(7.84%)
General Aviation1	(21.84%)	(15.29%)	(32.39%)	0.46%	(2.38%)	6.27%	(12.81%)	(28.60%)	15.00%	1.99%	(7.04%)	(16.81%)	(7.59%)
Military & Other	(28.64%)	(22.73%)	30.43%	(29.62%)	1.68%	(2.39%)	(74.26%)	0.80%	(0.30%)	10.57%	(5.36%)	-	(5.36%)
Total	**(11.85%)**	**(10.60%)**	**(14.08%)**	**(1.18%)**	**(3.16%)**	**(3.17%)**	**(13.82%)**	**(27.76%)**	**2.81%**	**(0.01%)**	**(7.94%)**	**(6.99%)**	**(7.65%)**
2008 Percent of Total	**10.34%**	**7.69%**	**6.68%**	**6.11%**	**7.78%**	**5.54%**	**4.05%**	**3.91%**	**3.35%**	**13.75%**	**69.20%**	**30.80%**	**100.00%**

Table F-2 Percentage Change in Aircraft Operations by Classification for New England's Airports, 2000 to 2017 (Continued)

Airport	Bradley International	T.F. Green	Manchester-Boston Regional	Portland International Jetport	Burlington	Bangor	Tweed-New Haven	Worcester Regional	Portsmouth International	Hanscom Field[2]	Subtotal	Logan[3]	Total
2008 to 2009													
Commercial	(16.47%)	(14.86%)	(14.44%)	(12.06%)	(17.65%)	(14.51%)	(22.85%)	(1.02%)	(68.67%)	(100.00%)	(15.43%)	(4.23%)	(9.77%)
General Aviation1	(14.50%)	(0.16%)	(11.38%)	(20.07%)	(29.14%)	(27.94%)	(15.50%)	(4.71%)	(18.97%)	(9.44%)	(14.09%)	(48.61%)	(15.83%)
Military & Other	(25.05%)	39.04%	38.45%	(20.12%)	(10.94%)	(20.45%)	100.00%	(98.08%)	(14.29%)	(23.58%)	(17.42%)	-	(17.42%)
Total	**(16.36%)**	**(11.67%)**	**(13.27%)**	**(15.63%)**	**(22.64%)**	**(21.78%)**	**(15.53%)**	**(6.27%)**	**(19.70%)**	**(9.63%)**	**(14.82%)**	**(7.08%)**	**(12.44%)**
2009 Percent of Total	**9.88%**	**7.76%**	**6.61%**	**5.88%**	**6.88%**	**4.95%**	**3.91%**	**4.19%**	**3.07%**	**14.19%**	**67.31%**	**32.69%**	**100.00%**
2009 to 2010													
Commercial	(1.95%)	(3.38%)	(0.67%)	(2.43%)	(5.18%)	(1.79%)	3.39%	(35.54%)	259.24%	-	(2.27%)	1.47%	(0.27%)
General Aviation1	(4.22%)	8.53%	(5.00%)	(2.74%)	9.84%	2.99%	(15.48%)	0.34%	2.04%	8.91%	2.94%	19.93%	3.46%
Military & Other	11.08%	33.46%	(19.78%)	(42.67%)	(44.65%)	(4.56%)	(21.60%)	3264.71%	12.49%	47.74%	(7.50%)	-	(7.50%)
Total	**(2.04%)**	**(0.44%)**	**(1.88%)**	**(3.06%)**	**(3.07%)**	**(0.87%)**	**(14.13%)**	**(0.45%)**	**7.59%**	**9.22%**	**0.26%**	**2.12%**	**0.87%**
2010 Percent of Total	**9.59%**	**7.65%**	**6.43%**	**5.65%**	**6.61%**	**4.87%**	**3.33%**	**4.13%**	**3.27%**	**15.37%**	**66.91%**	**33.09%**	**100.00%**
2010 to 2011													
Commercial	7.98%	(4.88%)	(4.80%)	0.35%	(1.26%)	(0.08%)	5.19%	23.82%	13.26%	-	0.76%	0.83%	0.80%
General Aviation1	(12.13%)	3.21%	(8.35%)	(13.41%)	17.88%	(3.17%)	6.38%	5.27%	5.38%	(0.68%)	1.08%	92.28%	4.34%
Military & Other	19.88%	6.34%	(6.32%)	19.51%	23.32%	(14.85%)	(18.64%)	10.84%	5.85%	(21.50%)	(1.36%)	-	(1.36%)
Total	**4.64%**	**(2.74%)**	**(5.53%)**	**(5.17%)**	**10.22%**	**(5.70%)**	**6.01%**	**6.03%**	**5.83%**	**(0.45%)**	**0.83%**	**4.63%**	**2.09%**
2011 Percent of Total	**9.83%**	**7.29%**	**5.95%**	**5.25%**	**7.13%**	**4.49%**	**3.46%**	**4.29%**	**3.39%**	**14.98%**	**66.08%**	**33.92%**	**100.00%**
2012 to 2013													
Commercial	(1.87%)	(3.90%)	(3.98%)	(6.17%)	(0.93%)	(0.80%)	4.01%	(3.23%)	11.55%	(60.16%)	(3.07%)	2.42%	0.00%
General Aviation1	(2.55%)	(0.21%)	(8.57%)	(4.04%)	(4.58%)	(14.02%)	(17.20%)	(22.90%)	(4.09%)	(6.75%)	(8.60%)	(5.09%)	(8.37%)
Military & Other	(31.35%)	0.23%	14.07%	(19.35%)	(1.51%)	(3.98%)	1.68%	(19.86%)	(4.35%)	(28.32%)	(6.98%)	-	(6.98%)
Total	**(3.09%)**	**(2.66%)**	**(4.63%)**	**(5.49%)**	**(3.01%)**	**(7.01%)**	**(14.86%)**	**(22.13%)**	**(3.94%)**	**(7.05%)**	**(6.48%)**	**1.82%**	**(3.68%)**
2013 Percent of Total	**9.46%**	**7.25%**	**5.54%**	**5.09%**	**7.32%**	**4.07%**	**3.28%**	**3.46%**	**3.66%**	**15.23%**	**64.37%**	**35.63%**	**100.00%**

Table F-2 Percentage Change in Aircraft Operations by Classification for New England's Airports, 2000 to 2017 (Continued)

Airport	Bradley International	T.F. Green	Manchester-Boston Regional	Portland International Jetport	Burlington	Bangor	Tweed-New Haven	Worcester Regional	Portsmouth International	Hanscom Field[2]	Subtotal	Logan[3]	Total
2013 to 2014													
Commercial	1.08%	(8.25%)	(11.24%)	(4.95%)	(2.82%)	(1.90%)	17.12%	49.31%	1378.21%	1.19%	(0.57%)	0.81%	0.23%
General Aviation1	(2.90%)	19.25%	7.53%	(17.41%)	1.10%	0.08%	(8.76%)	(11.40%)	(15.58%)	(13.19%)	(7.78%)	(1.00%)	(7.32%)
Military & Other	4.18%	138.16%	(25.82%)	18.90%	(1.86%)	4.73%	25.06%	61.21%	0.63%	13.80%	4.60%	-	4.60%
Total	**0.54%**	**1.87%**	**(7.74%)**	**(9.57%)**	**(0.60%)**	**0.62%**	**(5.15%)**	**(7.43%)**	**8.78%**	**(13.07%)**	**(4.42%)**	**0.68%**	**(2.60%)**
2014 Percent of Total	**9.77%**	**7.58%**	**5.25%**	**4.72%**	**7.47%**	**4.21%**	**3.20%**	**3.29%**	**4.08%**	**13.60%**	**63.17%**	**36.83%**	**100.00%**
2014 to 2015													
Commercial	(3.33%)	(4.36%)	(1.59%)	2.97%	(3.37%)	(5.61%)	31.72%	1.94%	3.25%	(14.06%)	(1.69%)	2.19%	0.54%
General Aviation1	(2.37%)	(23.02%)	5.21%	8.35%	1.76%	6.04%	5.47%	22.56%	9.85%	(4.47%)	0.29%	6.62%	0.74%
Military & Other	0.56%	(58.49%)	(10.68%)	1.25%	(13.59%)	(7.63%)	29.49%	(7.01%)	(1.60%)	(1.66%)	(7.62%)	-	(7.62%)
Total	**(3.08%)**	**(12.46%)**	**(0.13%)**	**4.86%**	**(1.48%)**	**(1.81%)**	**9.86%**	**20.18%**	**6.33%**	**(4.48%)**	**(0.92%)**	**2.51%**	**0.34%**
2015 Percent of Total	**9.44%**	**6.61%**	**5.23%**	**4.93%**	**7.33%**	**4.12%**	**3.50%**	**3.94%**	**4.33%**	**12.94%**	**62.37%**	**37.63%**	**100.00%**
2015 to 2016													
Commercial	0.98%	2.93%	6.64%	5.77%	4.87%	7.23%	13.92%	8.37%	10.39%	20.91%	4.31%	4.55%	4.45%
General Aviation1	0.40%	14.68%	11.70%	2.33%	(7.12%)	1.99%	3.97%	(10.79%)	8.18%	(5.16%)	(1.29%)	9.28%	(0.49%)
Military & Other	18.58%	(7.67%)	(38.22%)	(13.93%)	3.42%	5.49%	(0.29%)	(12.26%)	18.86%	6.76%	7.18%	-	7.18%
Total	**1.40%**	**6.93%**	**7.20%**	**4.28%**	**(2.11%)**	**4.66%**	**5.70%**	**(9.64%)**	**10.48%**	**(5.06%)**	**1.34%**	**4.90%**	**2.68%**
2016 Percent of Total	**9.32%**	**6.89%**	**5.46%**	**5.01%**	**6.99%**	**4.20%**	**3.61%**	**3.46%**	**4.66%**	**11.97%**	**61.55%**	**38.45%**	**100.00%**
2016 to 2017													
Commercial	1.63%	4.97%	(6.75%)	2.10%	1.06%	8.70%	(5.21%)	11.81%	1.72%	10.90%	1.20%	2.72%	2.09%
General Aviation1	(8.49%)	0.93%	(8.85%)	0.32%	(10.95%)	2.03%	(36.17%)	(17.35%)	8.65%	5.90%	(3.65%)	1.10%	(3.26%)
Military & Other	(5.41%)	23.43%	39.12%	16.39%	(16.91%)	(11.41%)	(15.96%)	8.97%	(8.56%)	20.09%	(8.49%)	-	(8.49%)
Total	**(0.15%)**	**3.58%**	**(6.88%)**	**1.59%**	**(7.01%)**	**0.77%**	**(29.73%)**	**(14.60%)**	**4.03%**	**5.98%**	**(1.94%)**	**2.59%**	**(0.20%)**
2017 Percent of Total	**9.32%**	**7.15%**	**5.09%**	**5.10%**	**6.51%**	**4.24%**	**2.54%**	**2.96%**	**4.85%**	**12.71%**	**60.48%**	**39.52%**	**100.00%**

Source: Massport, Federal Aviation Administration (FAA) Tower Counts, and individual airport records.

1 Includes itinerant and local general aviation operations at the regional airports. There are no local (touch-and-go training) operations at Logan Airport.

2 Commercial operations at Hanscom Field include scheduled commercial operations only; other air taxi operations counted as GA.

3 Operations at Logan Airport include international operations.

Table F-3 Scheduled Passenger Operations by Market and Carrier for Bradley International Airport

			Departures												Departing Seats											
Carrier	Market	Code	2000	2005	2010	2011	2012	2013	2014	2015	2016	2017	'16-'17 Change	'16-'17 Pct. Change	2000	2005	2010	2011	2012	2013	2014	2015	2016	2017	'16-'17 Change	'16-'17 Pct. Change
Jet Carriers																										
Aer Lingus	Dublin	DUB									66	305	239	361.7%									11,657	53,934	42,277	362.7%
Alaska	Chicago O'Hare	ORD	30										-	-	4,050										-	-
America West	Columbus	CMH	149										-	-	18,441										-	-
America West	Las Vegas	LAS	210										-	-	27,469										-	-
America West	Phoenix	PHX	275	365									-	-	37,772	54,570									-	-
American	Charlotte	CLT							1,763	1,775	1,918	1,982	64	3.3%							257,645	244,756	278,511	306,378	27,867	10.0%
American	Chicago O'Hare	ORD	2,139	1,570							240	671	431	179.6%	304,855	203,929							35,717	102,663	66,946	187.4%
American	Dallas/Fort Worth	DFW	1,343	1,052	1,052	1,078	1,068	1,069	1,008	695	678	678	-	0.0%	185,922	136,897	160,983	172,457	170,811	171,017	157,952	103,576	101,001	103,275	2,274	2.3%
American	Los Angeles	LAX	214					122	243		205	330	125	61.0%	31,244					19,520	38,880		30,588	50,150	19,562	64.0%
American	Miami	MIA	366	365	413	516	366	396	476	400	365	361	-4	-1.0%	51,427	49,990	63,559	82,560	58,560	63,360	74,981	59,600	54,342	55,105	763	1.4%
American	Philadelphia	PHL							265	31	271	382	111	41.0%							29,004	3,069	28,245	38,044	9,799	34.7%
American	New York J F Kennedy	JFK											-	-											-	-
American	San Juan	SJU	366	365	365	365	91						-	-	69,348	84,425	55,856	58,400	14,560						-	-
American	St. Louis	STL											-	-											-	-
American	Washington National	DCA							103	18	17	4	-13	-76.5%							12,536	2,196	1,680	567	-1,113	-66.3%
Boston-Maine Airways	Fort Lauderdale/Hollywood	FLL		13									-	-		1,993									-	-
Continental	Cleveland	CLE	582	131									-	-	68,974	16,262									-	-
Continental	Houston Intercontinental	IAH	366	313									-	-	45,790	34,072									-	-
Continental	New York Newark	EWR	331										-	-	38,916										-	-
Delta	Atlanta	ATL	2,192	3,098	2,099	2,094	2,105	2,109	2,391	2,374	2,360	2,290	-70	-3.0%	392,835	479,098	300,185	310,149	317,331	319,290	355,968	354,751	354,943	343,403	-11,540	-3.3%
Delta	Boston	BOS	4										-	-	634										-	-
Delta	Cancun	CUN			35	35	17	13	17	35	39	35	-4	-10.3%			5,470	5,397	2,735	1,973	2,571	5,207	5,956	5,049	-907	-15.2%
Delta	Cincinnati	CVG	1,464	1,373						4			-	-	244,837	196,741						471			-	-
Delta	Detroit	DTW			1,003	658	506	753	1,053	1,375	1,366	1,333	-33	-2.4%			129,228	91,657	73,117	110,361	145,867	187,833	184,729	183,762	-967	-0.5%

Table F-3 Scheduled Passenger Operations by Market and Carrier for Bradley International Airport (Continued)

			Departures												Departing Seats											
Carrier	Market	Code	2000	2005	2010	2011	2012	2013	2014	2015	2016	2017	'16-'17 Change	'16-'17 Pct. Change	2000	2005	2010	2011	2012	2013	2014	2015	2016	2017	'16-'17 Change	'16-'17 Pct. Change
Jet Carriers																										
Delta	Fort Lauderdale/Hollywood	FLL	732	673	237	210							-	-	87,108	133,927	33,674	29,280							-	-
Delta	Fort Myers	RSW			99	90							-	-			13,104	12,780							-	-
Delta	Las Vegas	LAS			9								-	-			1,394								-	-
Delta	Los Angeles	LAX		100	83								-	-		19,928	13,257								-	-
Delta	Minneapolis	MSP			758	576	511	549	605	858	662	803	141	21.3%			99,431	79,418	75,291	82,545	87,377	114,722	96,039	105,445	9,406	9.8%
Delta	New York J F Kennedy	JFK	183										-	-	39,894										-	-
Delta	Orlando	MCO	1,838	1,095	261	608		57			4	0	-4	-100.0%	218,705	217,905	99,129	88,041		8,514			471	0	-471	-100.0%
Delta	Salt Lake City	SLC		27									-	-		3,986									-	-
Delta	Tampa	TPA		678	813	120							-	-		134,894	33,625	15,420							-	-
Delta	West Palm Beach	PBI	732	516	205	120							-	-	87,108	102,684	37,536	16,500							-	-
Frontier Airlines	Denver	DEN											-	-											-	-
jetBlue	Washington National	DCA							402	730	714	730	16	2.2%							40,229	85,300	77,600	73,000	-4,600	-5.9%
jetBlue	Fort Lauderdale/Hollywood	FLL			101	599	627	612	590	590	568	726	158	27.8%			15,086	90,231	94,029	91,800	87,836	88,479	85,264	108,836	23,572	27.6%
jetBlue	Fort Myers	RSW						61	181	212	242	242	-	0.0%						9,150	27,150	31,800	36,300	36,300	-	0.0%
jetBlue	Orlando	MCO			101	730	723	730	747	730	746	730	-16	-2.1%			15,086	109,860	108,300	109,500	112,071	109,500	111,100	109,500	-1,600	-1.4%
jetBlue	San Juan	SJU					366	365	405	465	561	587	26	4.6%					54,900	54,793	60,729	69,686	84,150	88,114	3,964	4.7%
jetBlue	Tampa	TPA						61	365	365	365	409	44	12.1%						9,150	44,693	48,750	54,750	61,286	6,536	11.9%
jetBlue	West Palm Beach	PBI					366	365	365	365	387	365	-22	-5.7%					45,700	54,750	44,907	45,550	51,929	51,700	-229	-0.4%
Laker Airways (Bahamas)	Freeport	FPO	39										-	-	5,850										-	-
Midway Airlines	Raleigh/Durham	RDU	683										-	-	69,213										-	-
Midwest/Republic	Milwaukee	MKE	619										-	-	44,455										-	-
Northwest	Amsterdam	AMS											-	-											-	-
Northwest	Detroit	DTW	1,699	1,451									-	-	215,750	192,679									-	-

Table F-3 Scheduled Passenger Operations by Market and Carrier for Bradley International Airport (Continued)

			Departures												Departing Seats											
Carrier	Market	Code	2000	2005	2010	2011	2012	2013	2014	2015	2016	2017	'16-'17 Change	'16-'17 Pct. Change	2000	2005	2010	2011	2012	2013	2014	2015	2016	2017	'16-'17 Change	'16-'17 Pct. Change
Jet Carriers																										
Northwest	Fort Myers	RSW											-	-											-	-
Northwest	Minneapolis	MSP	1,177	1,042									-	-	135,570	140,194									-	-
Northwest	Orlando	MCO											-	-											-	-
Northwest	Tampa	TPA											-	-											-	-
Northwest	West Palm Beach	PBI											-	-											-	-
Norwegian Air Shuttle	Edinburgh	EDI										70	70	-										13,124	13,124	-
Southwest	Atlanta	ATL						174	1,086	172			-	-						20,391	131,627	24,482			-	-
Southwest	Baltimore	BWI	2,841	3,094	2,700	2,708	2,658	2,610	2,448	2,435	2,514	2,486	-28	-1.1%	389,158	423,878	367,534	367,414	362,995	372,650	353,791	353,038	372,278	363,930	-8,348	-2.2%
Southwest	Chicago Midway	MDW	723	953	923	979	964	967	961	974	966	944	-22	-2.3%	99,090	130,541	126,412	133,267	133,533	146,270	142,513	147,672	148,701	139,257	-9,444	-6.4%
Southwest	Denver	DEN			306	365	366	365	374	374	374	404	30	8.0%			41,922	50,005	50,982	54,860	58,570	61,917	60,234	67,673	7,439	12.4%
Southwest	Fort Lauderdale/Hollywood	FLL			70	365	366	348	369	387	387	387	-	0.0%			9,551	50,005	50,272	49,521	53,381	57,309	56,240	59,892	3,652	6.5%
Southwest	Fort Myers	RSW					147	203	216	212	212	276	64	30.2%					20,413	28,917	30,949	30,586	30,586	42,698	12,112	39.6%
Southwest	Las Vegas	LAS	52	365	361	365	270	245	245	306	306	245	-61	-19.9%	7,163	50,005	49,398	50,005	40,466	34,876	35,035	44,037	46,551	40,640	-5,911	-12.7%
Southwest	Nashville	BNA	672	365	361	304							-	-	92,064	50,005	49,398	41,648							-	-
Southwest	Orlando	MCO	375	1,108	1,016	1,003	997	944	975	1,003	999	1,056	57	5.7%	51,336	151,816	139,212	137,411	137,843	136,115	140,866	151,806	156,562	157,068	506	0.3%
Southwest	Philadelphia	PHL		1,590									-	-		217,850									-	-
Southwest	Tampa	TPA		695	570	656	623	629	656	651	642	712	70	10.9%		95,156	78,129	89,852	85,873	90,219	93,662	93,905	93,646	108,758	15,112	16.1%
Southwest	West Palm Beach	PBI				61				4	4	9	5	125.0%				8,357				633	633	1,246	613	96.8%
Spirit	Fort Lauderdale/Hollywood	FLL										184	184	-										26,680	26,680	-
Spirit	Fort Myers	RSW										61	61	-										11,102	11,102	-
Spirit	Myrtle Beach	MYR										140	140	-										25,558	25,558	-
Spirit	Orlando	MCO										245	245	-										37,782	37,782	-

Table F-3 Scheduled Passenger Operations by Market and Carrier for Bradley International Airport (Continued)

			Departures												Departing Seats											
Carrier	**Market**	**Code**	**2000**	**2005**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**'16-'17 Change**	**'16-'17 Pct. Change**	**2000**	**2005**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**'16-'17 Change**	**'16-'17 Pct. Change**
Jet Carriers																										
Spirit	Tampa	TPA										61	61	-										11,102	11,102	-
Sunworld International	Philadelphia	PHL											-	-											-	-
Trans World Airlines	Portland (ME)	PWM	305										-	-	43,310										-	-
Trans World Airlines	St. Louis	STL	1,460										-	-	206,109										-	-
United	Chicago O'Hare	ORD	2,034	1,812	1,296	1,077	697	593	800	554	605	727	122	20.2%	299,522	259,437	198,709	159,738	104,725	86,911	112,864	72,529	84,972	100,094	15,122	17.8%
United	Denver	DEN	366								275	365	90	32.7%	46,901								36,838	53,945	17,107	46.4%
United	New York Newark	EWR						18				190	190	-						2,126				27,237	27,237	-
United	San Francisco	SFO	366									75	75	-	45,384									8,983	8,983	-
United	Washington Dulles	IAD	1,455	726	1,192	812	514	180	222	82	472	430	-42	-8.9%	173,869	81,631	155,750	108,500	66,780	25,418	32,132	11,182	73,998	64,261	-9,737	-13.2%
US Airways	Baltimore	BWI	488										-	-	41,760										-	-
US Airways	Charlotte	CLT	1,464	2,188	1,588	1,664	1,665	1,734					-	-	214,719	350,776	228,119	238,508	241,320	255,885					-	-
US Airways	Fort Lauderdale/ Hollywood	FLL	366	123									-	-	39,232	15,161									-	-
US Airways	Orlando	MCO	1,098	30									-	-	117,696	3,842									-	-
US Airways	Philadelphia	PHL	2,148	2,102	361	317	340	365					-	-	310,118	301,242	49,914	44,595	46,989	49,083					-	-
US Airways	Phoenix	PHX											-	-											-	-
US Airways	Pittsburgh	PIT	1,800	27									-	-	278,575	3,189									-	-
US Airways	Washington Dulles	IAD	732										-	-	86,376										-	-
US Airways	Washington National	DCA	1,329	1,064	361	365	335	208					-	-	171,891	141,068	51,434	52,210	46,511	25,610					-	-
US Airways	West Palm Beach	PBI	366										-	-	39,232										-	-
USA 3000 Airlines	Cancun	CUN		26									-	-		4,336									-	-
USA 3000 Airlines	Punta Cana	PUJ		13									-	-		2,128									-	-
Subtotal			**38,171**	**30,507**	**18,695**	**18,841**	**16,686**	**16,845**	**19,331**	**18,175**	**19,530**	**22,030**	**2,500**	**12.8%**	**5,179,671**	**4,486,236**	**2,622,086**	**2,693,666**	**2,404,036**	**2,484,577**	**2,765,786**	**2,604,342**	**2,846,211**	**3,237,541**	**391,330**	**13.7%**

Table F-3 Scheduled Passenger Operations by Market and Carrier for Bradley International Airport (Continued)

			Departures												Departing Seats											
Carrier	Market	Code	2000	2005	2010	2011	2012	2013	2014	2015	2016	2017	'16-'17 Change	'16-'17 Pct. Change	2000	2005	2010	2011	2012	2013	2014	2015	2016	2017	'16-'17 Change	'16-'17 Pct. Change
Regional/ Commuter Carriers																										
Air Canada Express	Montreal Dorval	YUL	1,385	1,038	1,021	986	976	952	996	1,008	1,038	1,021	30	3.0%	19,392	19,475	19,399	18,739	18,549	17,144	17,925	18,141	18,692	18,381	551	3.0%
Air Canada Express	Toronto	YYZ	1,589	1,342	1,287	1,308	1,294	1,295	1,313	1,395	1,399	1,391	4	0.3%	61,991	38,242	36,960	38,342	33,044	28,103	25,102	25,118	35,328	40,045	10,210	40.6%
America West Express	Columbus	CMH	450										-	-	22,493										-	-
American Connection	St. Louis	STL		947									-	-		44,356									-	-
American Eagle	Charlotte	CLT							366	290	156	127	-134	-46.1%							28,940	22,265	11,774	10,062	-10,491	-47.1%
American Eagle	Chicago O'Hare	ORD			1,501	1,630	1,613	1,630	1,622	1,604	1,421	685	-183	-11.4%			79,594	95,985	80,413	90,663	115,856	115,366	93,468	43,137	-21,898	-19.0%
American Eagle	New York J F Kennedy	JFK	1,460										-	-	48,166										-	-
American Eagle	Philadelphia	PHL							2,234	2,502	2,133	1,684	-369	-14.8%							136,683	146,222	123,285	103,743	-22,937	-15.7%
American Eagle	Pittsburgh	PIT							939	782			-782	-100.0%							67,549	39,086			-39,086	-100.0%
American Eagle	Raleigh/Durham	RDU		1,364	257								-	-		54,521	10,774								-	-
American Eagle	St. Louis	STL											-	-											-	-
American Eagle	Washington National	DCA							2,119	2,125	2,251	2,476	126	5.9%							141,783	130,975	142,309	147,169	11,334	8.7%
Continental Connection	Albany	ALB		51									-	-		961									-	-
Continental Connection	Binghamton	BGM											-	-											-	-
Continental Connection	Boston	BOS											-	-											-	-
Continental Connection	Buffalo	BUF	89										-	-	1,683										-	-
Continental Connection	Burlington	BTV	4										-	-	84										-	-
Continental Connection	New York J F Kennedy	JFK											-	-											-	-

Table F-3 Scheduled Passenger Operations by Market and Carrier for Bradley International Airport (Continued)

			Departures												Departing Seats											
Carrier	**Market**	**Code**	**2000**	**2005**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**'16-'17 Change**	**'16-'17 Pct. Change**	**2000**	**2005**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**'16-'17 Change**	**'16-'17 Pct. Change**
Regional/ Commuter Carriers																										
Continental Connection	New York Newark	EWR			608								-	-			22,485								-	-
Continental Connection	Philadelphia	PHL											-	-											-	-
Continental Connection	Rochester	ROC	93										-	-	1,767										-	-
Continental Connection	Syracuse	SYR	97										-	-	1,851										-	-
Continental Express	Cleveland	CLE	803	1,102	1,208								-	-	39,357	54,951	60,400								-	-
Continental Express	New York Newark	EWR	1,747	1,351	465								-	-	82,365	67,455	23,264								-	-
Delta Connection	Atlanta	ATL				48	9	4	4	4			-4	-100.0%				3,396	647	279	288	326			-326	-100.0%
Delta Connection	Cincinnati	CVG			1,218	1,251	902	895	839	475	300	308	-175	-36.8%			61,642	66,559	45,181	44,757	43,557	25,537	22,800	22,353	-2,737	-10.7%
Delta Connection	Cleveland	CLE							170	243	266	300	23	9.5%							11,898	15,450	19,798	22,800	4,348	28.1%
Delta Connection	Columbus	CMH		994									-	-		49,196									-	-
Delta Connection	Detroit	DTW			1,004	1,323	1,429	1,195	659	313	264	271	-49	-15.7%			54,265	82,915	100,525	80,351	45,421	20,860	18,905	20,193	-1,955	-9.4%
Delta Connection	Fort Lauderdale/Hollywood	FLL											-	-											-	-
Delta Connection	Fort Myers	RSW		612									-	-		42,840									-	-
Delta Connection	Indianapolis	IND											-	-											-	-
Delta Connection	Minneapolis	MSP			481	814	858	812	738	342	539	467	197	57.6%			36,567	61,731	64,643	61,035	55,233	25,556	40,845	34,547	15,289	59.8%
Delta Connection	Myrtle Beach	MYR	61										-	-	3,057										-	-
Delta Connection	New York J F Kennedy	JFK			365	304	183						-	-			18,250	15,200	9,216						-	-
Delta Connection	Orlando	MCO							43	35	8	9	-27	-77.1%							3,156	2,354	641	662	-1,713	-72.8%
Delta Connection	Raleigh/Durham	RDU			100	569	454	270	257	261	253	308	-8	-3.1%			6,136	28,436	22,686	13,500	12,850	17,611	18,054	23,441	443	2.5%

Table F-3 Scheduled Passenger Operations by Market and Carrier for Bradley International Airport (Continued)

			Departures												Departing Seats											
Carrier	Market	Code	2000	2005	2010	2011	2012	2013	2014	2015	2016	2017	'16-'17 Change	'16-'17 Pct. Change	2000	2005	2010	2011	2012	2013	2014	2015	2016	2017	'16-'17 Change	'16-'17 Pct. Change
Regional/ Commuter Carriers																										
Delta Connection	Tampa	TPA											-	-											-	-
Delta Connection	Washington National	DCA			166	929	360						-	-			11,324	51,524	18,074						-	-
Delta Connection	West Palm Beach	PBI											-	-											-	-
Frontier Express	Milwaukee	MKE			140	417							-	-			6,313	18,746							-	-
Independence Air	Washington Dulles	IAD		1,966									-	-		98,307									-	-
Midway Airlines	Raleigh/Durham	RDU	1,348										-	-	67,393										-	-
Midwest Connect	Milwaukee	MKE	4	965									-	-	142	30,871									-	-
Northwest Airlink	Detroit	DTW											-	-											-	-
Northwest Airlink	Indianapolis	IND		638									-	-		31,907									-	-
Northwest Airlink	Memphis	MEM											-	-											-	-
Northwest Airlink	Minneapolis	MSP		31									-	-		1,550									-	-
OneJet	Pittsburgh	PIT									289	521	289	-									2,597	4,344	2,597	-
Shuttle America	Albany	ALB	66										-	-	3,286										-	-
Shuttle America	Bedford	BED	233										-	-	11,671										-	-
Shuttle America	Buffalo	BUF	337										-	-	16,857										-	-
Shuttle America	Islip	ISP	27										-	-	1,329										-	-
Shuttle America	Wilmington	ILG	159										-	-	7,936										-	-
Swissair	New York J F Kennedy	JFK	31										-	-	1,023										-	-
Trans World Airlines	New York J F Kennedy	JFK	1,098										-	-	31,842										-	-
United Express	Chicago O'Hare	ORD		691	548	685	1,038	1,045	877	904	696	509	-208	-23.0%		48,370	36,797	43,701	63,807	59,896	47,419	60,980	45,255	34,256	-15,725	-25.8%
United Express	Cleveland	CLE				1,200	1,125	1,127	235				-	-				59,979	55,744	56,436	11,750				-	-
United Express	Houston	IAH							96	365	361	293	-4	-1.1%							7,521	26,998	25,240	20,583	-1,758	-6.5%
United Express	New York Newark	EWR				1,159	1,347	1,269	853	1,335	1,357	866	22	1.6%				46,231	56,787	61,339	38,317	65,086	69,442	39,881	4,356	6.7%

Table F-3 Scheduled Passenger Operations by Market and Carrier for Bradley International Airport (Continued)

			Departures												Departing Seats											
Carrier	Market	Code	2000	2005	2010	2011	2012	2013	2014	2015	2016	2017	'16-'17 Change	'16-'17 Pct. Change	2000	2005	2010	2011	2012	2013	2014	2015	2016	2017	'16-'17 Change	'16-'17 Pct. Change
Regional/ Commuter Carriers																										
United Express	Washington Dulles	IAD		1,519	494	889	928	1,280	1,224	1,243	870	965	-373	-30.0%		84,484	30,270	54,707	59,507	72,861	68,684	77,783	56,035	61,327	-21,748	-28.0%
US Airways Express	Baltimore	BWI	1,185										-	-	43,850										-	-
US Airways Express	Buffalo	BUF	1,032	839									-	-	38,200	28,607									-	-
US Airways Express	Charlotte	CLT		4	537	452	462	364					-	-		221	45,043	37,510	39,235	28,392					-	-
US Airways Express	New York La Guardia	LGA			139	1,057	364						-	-			5,159	39,098	13,468						-	-
US Airways Express	New York Newark	EWR											-	-											-	-
US Airways Express	Philadelphia	PHL		439	2,404	2,430	2,356	2,260					-	-		27,685	183,838	163,675	151,526	133,663					-	-
US Airways Express	Pittsburgh	PIT		1,646	939	939	941	939					-	-		84,598	46,929	46,929	47,057	77,901					-	-
US Airways Express	Rochester	ROC	937	574	478								-	-	34,658	19,555	16,242								-	-
US Airways Express	Syracuse	SYR	732	478									-	-	27,084	9,077									-	-
US Airways Express	Washington National	DCA		551	1,334	1,411	1,574	1,825					-	-		34,454	89,629	89,940	109,321	115,989					-	-
Subtotal			**14,968**	**19,143**	**16,694**	**19,799**	**18,212**	**17,164**	**15,584**	**15,226**	**13,601**	**12,201**	**-1,625**	**-10.7%**	**567,477**	**871,682**	**901,282**	**1,063,342**	**989,430**	**942,310**	**879,932**	**835,714**	**744,468**	**646,924**	**-91,246**	**-10.9%**
													-	-											-	-
Total			**53,139**	**49,651**	**35,389**	**38,640**	**34,898**	**34,009**	**34,915**	**33,402**	**33,131**	**34,231**	**-271**	**-0.8%**	**5,747,148**	**5,357,918**	**3,523,368**	**3,757,008**	**3,393,466**	**3,426,886**	**3,645,718**	**3,440,056**	**3,590,679**	**3,884,465**	**150,624**	**4.4%**

Source: OAG Schedules.

Notes: All Northwest Airlines operations included in Delta Air Lines from 2009 onwards (following 2008 merger).
All Continental Airlines operations included in United Airlines from 2011 onwards (following 2010 merger).
All AirTran Airways operations included in Southwest Airlines from 2012 onwards (following 2011 merger).
All US Airways operations included in American Airlines from 2014 onwards (following 2013 merger).

Table F-4 Scheduled Passenger Operations by Market and Carrier for T.F Green Airport

			Departures												Departing Seats											
Carrier	Market	Code	2000	2005	2010	2011	2012	2013	2014	2015	2016	2017	'16-'17 Change	'16-'17 Pct. Change	2000	2005	2010	2011	2012	2013	2014	2015	2016	2017	'16-'17 Change	'16-'17 Pct. Change
Jet Carriers																										
Allegiant Airways	Punta Gorda	PGD										27	27	-										4,779	4,779	-
Allegiant Airways	St. Petersburg/ Clearwater	PIE										19	19	-										3,363	3,363	-
Allegiant Airways	Cincinnati	CVG										13	13	-										2,028	2,028	-
American	Charlotte	CLT							1,275	1,176	1,274	1,392	118	9.3%							196,644	170,310	189,856	213,892	24,036	12.7%
American	Chicago O'Hare	ORD	1,464	1,113									-	-	203,104	143,522									-	-
American	Dallas/Fort Worth	DFW		365									-	-		47,085									-	-
American	Philadelphia	PHL							347	366	520	995	475	91.3%							34,381	36,514	50,988	97,768	46,780	91.7%
American	Washington National	DCA							77	52			-	-							9,566	6,483			-	-
Continental	Cleveland	CLE	569	13									-	-	69,771	1,630									-	-
Continental	Houston Intercontinental	IAH	366										-	-	45,946										-	-
Continental	New York Newark	EWR	738	282									-	-	96,448	34,808									-	-
Condor	Frankfurt	FRA								22	18		-18	-100.0%								5,940	4,783		-4,783	-100.0%
Delta	Atlanta	ATL	1,464	1,976	510	1,043	990	978	993	997	1,060	1,047	-13	-1.2%	207,888	290,915	72,461	150,526	147,729	145,241	148,012	148,078	156,507	155,384	-1,123	-0.7%
Delta	Cincinnati	CVG	732	695									-	-	103,944	89,235									-	-
Delta	Detroit	DTW			414	58		218	476	707	719	715	-4	-0.6%			50,065	7,139		30,414	62,046	87,078	91,281	90,875	-406	-0.4%
Delta	Fort Lauderdale/ Hollywood	FLL											-	-											-	-
Delta	Minneapolis	MSP			74								-	-			9,211								-	-
Delta	Orlando	MCO	732										-	-	87,108										-	-
Frontier	Denver	DEN										144	144	-										25,946	25,946	-
Frontier	Fort Myers	RSW										53	53	-										12,091	12,091	-
Frontier	Miami	MIA										92	92	-										16,560	16,560	-
Frontier	New Orleans	MSY										39	39	-										5,914	5,914	-
Frontier	Orlando	MCO										153	153	-										32,140	32,140	-
Frontier	Tampa	TPA										39	39	-										9,069	9,069	-
jetBlue	Fort Lauderdale/ Hollywood	FLL					31	365	365	365	365	365	-	0.0%					4,650	54,750	54,750	54,750	54,750	54,750	-	0.0%
jetBlue	Orlando	MCO					62	713	713	713	713	713	-	0.0%					9,300	103,786	106,886	106,886	106,886	106,886	-	0.0%
Laker Airways (Bahamas)	Freeport	FPO											-	-											-	-
Northwest	Detroit	DTW	1,682	1,550									-	-	200,509	202,255									-	-
Northwest	Minneapolis	MSP		539									-	-		68,977									-	-
Norwegian	Belfast	BFS										35	35	-										6,642	6,642	-

Table F-4 Scheduled Passenger Operations by Market and Carrier for T.F Green Airport (Continued)

			Departures												Departing Seats											
Carrier	Market	Code	2000	2005	2010	2011	2012	2013	2014	2015	2016	2017	'16-'17 Change	'16-'17 Pct. Change	2000	2005	2010	2011	2012	2013	2014	2015	2016	2017	'16-'17 Change	'16-'17 Pct. Change
Norwegian	Bergen	BGO										35	35	-										6,642	6,642	-
Norwegian	Cork	ORK										70	70	-										13,257	13,257	-
Norwegian	Dublin	DUB										114	114	-										21,546	21,546	-
Norwegian	Edinburgh	EDI										88	88	-										16,578	16,578	-
Norwegian	Fort De France	FDF										17	17	-										3,259	3,259	-
Norwegian	Pointe-A-Pitre	PTP										17	17	-										3,259	3,259	-
Norwegian	Shannon	SNN										53	53	-										9,936	9,936	-
Sata Internacional	Ponta Delgada	PDL									9	22	13	144.4%									1,966	4,852	2,886	146.8%
Southwest	Baltimore	BWI	3,913	4,180	3,260	3,043	3,128	3,004	2,820	2,793	2,793	2,719	-74	-2.6%	535,911	572,699	442,637	415,554	433,081	429,658	411,154	407,651	414,057	401,718	-12,339	-3.0%
Southwest	Chicago Midway	MDW	1,072	1,349	1,135	1,095	1,094	992	975	988	996	953	-43	-4.3%	146,844	184,813	153,121	149,877	150,303	154,633	156,543	158,640	153,783	147,916	-5,867	-3.8%
Southwest	Denver	DEN					366	304	9				-	-					51,110	44,281	1,246				-	-
Southwest	Fort Lauderdale/ Hollywood	FLL	9		594	590	500	479	474	477	485	507	22	4.5%	1,194		81,378	80,791	68,347	70,413	68,401	70,778	74,477	78,412	3,935	5.3%
Southwest	Fort Myers	RSW					86	40	44	48	52	82	30	57.7%					11,743	5,520	6,292	7,305	7,918	12,046	4,128	52.1%
Southwest	Houston	HOU	152										-	-	20,824										-	-
Southwest	Islip	ISP	608										-	-	83,237										-	-
Southwest	Kansas City	MCI	366	365									-	-	50,142	50,005									-	-
Southwest	Las Vegas	LAS		31	365	365	362						-	-		4,247	50,005	50,005	49,932						-	-
Southwest	Nashville	BNA	706	721	296	123							-	-	96,702	98,816	39,578	16,067							-	-
Southwest	Orlando	MCO	955	1,821	1,799	1,659	1,585	1,423	1,419	1,464	1,469	1,390	-79	-5.4%	130,855	249,418	245,156	225,244	216,998	210,082	204,947	215,253	219,994	209,238	-10,756	-4.9%
Southwest	Philadelphia	PHL		1,773	1,402	1,298							-	-		238,366	192,054	177,001							-	-
Southwest	Phoenix	PHX	366	726	361	365							-	-	50,142	99,403	49,398	50,005							-	-
Southwest	Tampa	TPA	745	1,086	813	808	763	753	748	735	713	673	-40	-5.6%	102,065	148,821	111,231	109,572	104,140	107,959	107,481	108,451	107,723	100,790	-6,933	-6.4%
Southwest	West Palm Beach	PBI						31	35	31	31	22	-9	-29.0%						4,433	5,046	4,433	4,433	3,105	-1,328	-30.0%
Southwest	Washington National	DCA									122	730	608	498.4%									19,119	104,390	85,271	446.0%
Spirit Airlines	Detroit	DTW		120									-	-		18,000									-	-
Spirit Airlines	Fort Lauderdale/ Hollywood	FLL		568									-	-		84,117									-	-
Spirit Airlines	Fort Myers	RSW		365									-	-		54,750									-	-
TACV	Praia	RAI								39	74	65	-9	-12.2%								7,739	14,578	13,003	-1,575	-10.8%
United	Chicago O'Hare	ORD	1,477	1,460	644	626	388	334	320	144	236		-236	-100.0%	239,076	200,677	82,802	78,487	48,697	46,258	42,658	17,570	31,940		-31,940	-100.0%
US Airways	Baltimore	BWI	2,462										-	-	263,921										-	-
US Airways	Charlotte	CLT	977	1,858	1,643	1,599	1,726	1,608					-	-	128,984	274,039	233,886	226,854	238,503	225,454					-	-

Table F-4 Scheduled Passenger Operations by Market and Carrier for T.F Green Airport (Continued)

			Departures												Departing Seats											
Carrier	Market	Code	2000	2005	2010	2011	2012	2013	2014	2015	2016	2017	'16-'17 Change	'16-'17 Pct. Change	2000	2005	2010	2011	2012	2013	2014	2015	2016	2017	'16-'17 Change	'16-'17 Pct. Change
US Airways	Fort Lauderdale/ Hollywood	FLL		17									-	-		2,186									-	-
US Airways	Orlando	MCO	52	43									-	-	5,605	5,831									-	-
US Airways	Philadelphia	PHL	1,830	2,182	1,299	1,012	399	313					-	-	253,015	312,890	130,008	101,987	39,529	30,973					-	-
US Airways	Pittsburgh	PIT	1,339	31									-	-	185,109	4,446									-	-
US Airways	Washington National	DCA	1,333	1,270	365	313	182	124					-	-	167,278	170,009	49,501	44,006	24,350	14,997					-	-
Subtotal			26,108	26,499	14,974	13,998	11,661	11,677	11,090	11,116	11,649	13,399	1,750	15.0%	3,475,622	3,651,961	1,992,492	1,883,114	1,598,412	1,678,851	1,616,053	1,613,859	1,705,039	1,988,034	282,995	16.6%
Regional/Commuter Carriers																										
Air Canada Express	Toronto	YYZ	989	734	625	591	593	84					-	-	37,482	13,783	11,880	11,232	11,262	1,517					-	-
American Eagle	Charlotte	CLT							175	341	301	187	-114	-37.9%							13,971	26,810	25,452	15,629	-9,823	-38.6%
American Eagle	Chicago O'Hare	ORD									550	717	167	30.4%									34,650	45,162	10,512	30.3%
American Eagle	Detroit	DTW					12						-	-					808						-	-
American Eagle	New York J F Kennedy	JFK	1,291										-	-	42,589										-	-
American Eagle	New York La Guardia	LGA	2,756										-	-	90,957										-	-
American Eagle	Raleigh/Durham	RDU		343									-	-		13,081									-	-
American Eagle	Philadelphia	PHL							2,213	2,163	1,982	1,035	-947	-47.8%							150,139	142,721	127,895	77,726	-50,169	-39.2%
American Eagle	Washington National	DCA							1,609	1,755	2,112	2,252	140	6.6%							111,183	111,865	138,655	148,758	10,103	7.3%
Cape Air	Block Island	BID							538	418			-	-							4,846	3,765			-	-
Cape Air	Hyannis	HYA											-	-											-	-
Cape Air	Martha's Vineyard	MVY	1,762	1,015	747	672	659	501	285	192			-	-	15,861	9,132	6,722	6,048	5,930	4,513	2,561	1,725			-	-
Cape Air	Nantucket	ACK	2,453	1,199	681	668	576	501	271	244			-	-	22,073	10,787	6,128	6,012	5,181	4,510	2,438	2,196			-	-
Continental Connection	Albany	ALB		51									-	-		961									-	-
Continental Connection	Boston	BOS											-	-											-	-
Continental Connection	New York Newark	EWR			427								-	-			31,630								-	-
Continental Connection	Plattsburgh	PLB											-	-											-	-
Continental Connection	Washington Dulles	IAD											-	-											-	-
Continental Express	Cleveland	CLE	699	1,238	1,217								-	-	34,936	61,900	60,836								-	-
Continental Express	New York Newark	EWR	1,482	1,455	1,028								-	-	86,552	71,185	51,407								-	-

Table F-4 Scheduled Passenger Operations by Market and Carrier for T.F Green Airport (Continued)

			Departures												Departing Seats											
Carrier	Market	Code	2000	2005	2010	2011	2012	2013	2014	2015	2016	2017	'16-'17 Change	'16-'17 Pct. Change	2000	2005	2010	2011	2012	2013	2014	2015	2016	2017	'16-'17 Change	'16-'17 Pct. Change
Delta Connection	Atlanta	ATL		31	724	9	43	70	51	43			-	-		1,550	52,959	662	3,279	4,522	3,380	3,001			-	-
Delta Connection	Cincinnati	CVG		373	43								-	-		19,109	2,150								-	-
Delta Connection	Detroit	DTW			1,324	1,995	2,054	1,748	871	289	324	279	-45	-13.9%			78,701	111,901	113,630	90,191	45,809	18,671	22,103	20,162	-1,941	-8.8%
Delta Connection	Minneapolis	MSP			347	392	266	240	170				-	-			26,192	29,553	20,189	17,380	12,878				-	-
Delta Connection	New York J F Kennedy	JFK											-	-											-	-
Delta Connection	New York La Guardia	LGA	610										-	-	19,520										-	-
Delta Connection	Raleigh/Durham	RDU				131							-	-				6,557							-	-
Delta Connection	Washington National	DCA				685	225						-	-				34,243	11,271						-	-
Independence Air	Washington Dulles	IAD		1,509									-	-		75,429									-	-
Midway Airlines	Raleigh/Durham	RDU											-	-											-	-
Northwest Airlink	Detroit	DTW											-	-											-	-
Northwest Airlink	Minneapolis	MSP		31									-	-		1,550									-	-
Onejet	Pittsburgh	PIT										87	87	-										610	610	-
United Express	Chicago O'Hare	ORD		262	455	375	309	306	325	605	464	673	209	45.0%		18,330	29,820	24,079	19,900	19,896	19,443	34,473	24,750	42,292	17,542	70.9%
United Express	Cleveland	CLE				1,079	886	875	102				-	-				53,943	42,991	43,757	5,100				-	-
United Express	New York Newark	EWR				1,439	1,346	1,213	994	1,356	1,355	1,382	27	2.0%				69,724	61,168	65,636	57,558	73,682	64,804	71,607	6,803	10.5%
United Express	Washington Dulles	IAD	1,468	1,716	1,569	1,421	1,157	1,035	1,031	837	886	782	-104	-11.7%	52,832	85,821	99,719	89,593	73,470	65,632	67,077	52,139	55,328	46,877	-8,451	-15.3%
US Airways Express	Albany	ALB	679										-	-	12,898										-	-
US Airways Express	Boston	BOS	48										-	-	909										-	-
US Airways Express	Charlotte	CLT		18	126	147	65	166					-	-		879	10,047	12,035	5,423	12,857					-	-
US Airways Express	Hyannis	HYA											-	-											-	-
US Airways Express	Nantucket	ACK											-	-											-	-
US Airways Express	New York La Guardia	LGA	2,298	1,669	1,222	957	286						-	-	84,116	55,077	45,225	33,141	10,582						-	-
US Airways Express	New York Newark	EWR	1,569										-	-	31,176										-	-
US Airways Express	Philadelphia	PHL	366	716	1,526	1,713	2,206	2,347					-	-	13,542	45,199	107,790	122,386	152,816	154,401					-	-
US Airways Express	Pittsburgh	PIT		1,360									-	-		72,808									-	-
US Airways Express	Plattsburgh	PLB	26										-	-	497										-	-
US Airways Express	Washington National	DCA		482	1,373	1,304	1,479	1,492					-	-		30,996	92,151	95,527	110,451	107,775					-	-
Subtotal			18,527	14,200	13,436	13,577	12,161	10,577	8,635	8,243	7,974	7,394	-580	-7.3%	546,963	587,576	713,356	706,634	648,351	592,587	496,383	471,048	493,637	468,823	-24,814	-5.0%
Total			44,635	40,699	28,409	27,575	23,822	22,255	19,725	19,359	19,623	20,793	1,170	6.0%	4,022,585	4,239,537	2,705,848	2,589,748	2,246,763	2,271,438	2,112,436	2,084,907	2,198,676	2,456,857	258,181	11.7%

Source: OAG Schedules.

Notes: Allegiant stopped reporting to the OAG in 2009, so Allegiant 2009-2015 statistics from the T100 database; 2016-2017 statistics from Innovata SRS.
All Northwest Airlines operations included in Delta Air Lines from 2009 onwards (following 2008 merger).
All Continental Airlines operations included in United Airlines from 2011 onwards (following 2010 merger).
All AirTran Airways operations included in Southwest Airlines from 2012 onwards (following 2011 merger).
All US Airways operations included in American Airlines from 2014 onwards (following 2013 merger).

Table F-5 Scheduled Passenger Operations by Market and Carrier for Manchester-Boston Regional Airport

			Departures												Departing Seats											
Carrier	Market	Code	2000	2005	2010	2011	2012	2013	2014	2015	2016	2017	'16-'17 Change	'16-'17 Pct. Change	2000	2005	2010	2011	2012	2013	2014	2015	2016	2017	'16-'17 Change	'16-'17 Pct. Change
Jet Carriers																										
American	Charlotte	CLT										52	52	-										6,674	6,674	-
Boston-Maine Airways	Myrtle Beach	MYR											-	-											-	-
Boston-Maine Airways	Portsmouth	PSM											-	-											-	-
Boston-Maine Airways	Sanford	SFB											-	-											-	-
Continental	Cleveland	CLE	130										-	-	16,151										-	-
Continental	New York Newark	EWR	462	286									-	-	62,358	30,953									-	-
Delta	Atlanta	ATL	244	668	275	565	514	463	459	365	365	365	-	0.0%	34,648	94,856	39,050	81,600	76,629	69,307	68,468	53,545	54,212	55,172	960	1.8%
Delta	Cincinnati	CVG		664									-	-		86,583									-	-
Delta	Detroit	DTW			796					122	87	26	-61	-70.1%			89,289					14,414	9,881	2,829	-7,052	-71.4%
Delta	New York - LGA	LGA								4			-	-								596			-	-
Northwest	Detroit	DTW	1,609	1,399									-	-	194,058	180,879									-	-
Northwest	Minneapolis	MSP		365									-	-		46,933									-	-
Southwest	Baltimore	BWI	2,828	3,850	2,891	2,761	2,775	2,726	2,494	2,476	2,576	2,393	-183	-7.1%	387,397	527,405	393,093	376,945	385,044	387,879	364,979	363,524	383,914	353,543	-30,371	-7.9%
Southwest	Chicago Midway	MDW	706	1,355	1,144	1,244	1,168	1,010	984	948	996	922	-74	-7.4%	96,702	185,481	155,466	169,440	161,822	158,820	157,501	148,825	153,459	143,869	-9,590	-6.2%
Southwest	Denver	DEN				92	366	304					-	-				12,604	50,379	43,211					-	-
Southwest	Fort Lauderdale/ Hollywood	FLL			9	9	152	90		4			-	-			1,194	1,194	21,190	12,793		633			-	-
Southwest	Kansas City	MCI	366										-	-	50,142										-	-
Southwest	Las Vegas	LAS		365	365	365	122	61	9	9			-	-		50,005	50,005	50,005	16,766	8,723	1,246	1,246			-	-
Southwest	Nashville	BNA	397	730									-	-	54,389	99,879									-	-
Southwest	Orlando	MCO	410	1,468	1,125	977	906	831	752	743	765	764	-1	-0.1%	56,111	201,175	154,145	133,829	125,620	123,873	109,202	113,888	118,422	115,387	-3,035	-2.6%
Southwest	Philadelphia	PHL		1,786	1,411	1,325							-	-		244,356	192,456	180,871							-	-
Southwest	Phoenix	PHX			322	273							-	-			44,114	37,401							-	-
Southwest	Tampa	TPA		1,099	782	629	579	466	470	479	487	461	-26	-5.3%		150,165	107,173	86,212	79,639	68,120	67,509	70,529	71,922	67,276	-4,646	-6.5%
United	Chicago O'Hare	ORD	1,403	1,339									-	-	221,523	179,151									-	-
United	Portland (ME)	PWM	57										-	-	7,241										-	-
US Airways	Baltimore	BWI	1,782										-	-	191,078										-	-
US Airways	Charlotte	CLT		1,308	365	51							-	-		178,836	52,560	7,406							-	-
US Airways	Orlando	MCO	52										-	-	5,605										-	-
US Airways	Philadelphia	PHL	1,821	2,021	365	313	187	351					-	-	222,331	274,215	33,132	30,973	18,499	34,791					-	-
US Airways	Pittsburgh	PIT	1,085										-	-	139,837										-	-
US Airways	Washington National	DCA	675	575									-	-	82,085	77,461									-	-
Subtotal			**14,026**	**19,279**	**9,850**	**8,604**	**6,769**	**6,302**	**5,168**	**5,150**	**5,276**	**4,983**	**-293**	**-5.6%**	**1,821,657**	**2,608,335**	**1,311,677**	**1,168,481**	**935,588**	**907,518**	**768,905**	**767,200**	**791,810**	**744,750**	**-47,060**	**-5.9%**

Table F-5 Scheduled Passenger Operations by Market and Carrier for Manchester-Boston Regional Airport (Continued)

			Departures												Departing Seats											
Carrier	Market	Code	2000	2005	2010	2011	2012	2013	2014	2015	2016	2017	'16-'17 Change	'16-'17 Pct. Change	2000	2005	2010	2011	2012	2013	2014	2015	2016	2017	'16-'17 Change	'16-'17 Pct. Change
Regional/ Commuter Carriers																										
Air Canada Express	Montreal Dorval	YUL											-	-											-	-
Air Canada Express	Toronto	YYZ	339	930	707	403							-	-	5,616	17,439	13,441	7,652							-	-
American Eagle	Charlotte	CLT							496	730	734	809	75	10.2%							37,761	54,688	60,890	67,927	7,037	11.6%
American Eagle	New York La Guardia	LGA	1,833										-	-	60,480										-	-
American Eagle	Philadelphia	PHL							2,295	2,237	2,090	2,066	-24	-1.1%							149,598	152,206	136,795	129,174	-7,621	-5.6%
American Eagle	Washington National	DCA							1,198	1,152	1,304	1,316	12	0.9%							77,065	74,008	85,620	84,908	-712	-0.8%
Boston-Maine Airways	Bangor	BGR											-	-											-	-
Boston-Maine Airways	Martha's Vineyard	MVY											-	-											-	-
Boston-Maine Airways	Nantucket	ACK											-	-											-	-
Boston-Maine Airways	New London/Groton	GON											-	-											-	-
Boston-Maine Airways	Portsmouth	PSM											-	-											-	-
Boston-Maine Airways	Saint John	YSJ											-	-											-	-
Continental Connection	Albany	ALB	80	313									-	-	1,515	5,944									-	-
Continental Connection	New York J F Kennedy	JFK											-	-											-	-
Continental Connection	New York Newark	EWR			141								-	-			9,483								-	-
Continental Connection	Plattsburgh	PLB											-	-											-	-
Continental Connection	Rochester	ROC	44										-	-	841										-	-
Continental Connection	Syracuse	SYR	22										-	-	421										-	-
Continental Connection	Westchester County	HPN											-	-											-	-
Continental Express	Cleveland	CLE	593	1,186	1,178								-	-	29,614	58,991	58,921								-	-
Continental Express	New York Newark	EWR	1,028	1,165	1,267								-	-	64,944	58,140	63,336								-	-
Delta Connection	Atlanta	ATL	488	485	90			51	59				-	-	24,400	26,620	6,300			3,843	4,484				-	-

Table F-5 Scheduled Passenger Operations by Market and Carrier for Manchester-Boston Regional Airport (Continued)

			Departures												Departing Seats											
Carrier	Market	Code	2000	2005	2010	2011	2012	2013	2014	2015	2016	2017	'16-'17 Change	'16-'17 Pct. Change	2000	2005	2010	2011	2012	2013	2014	2015	2016	2017	'16-'17 Change	'16-'17 Pct. Change
Delta Connection	Bangor	BGR	244										-	-		12,200									-	-
Delta Connection	Cincinnati	CVG	1,673	735									-	-		83,657	38,426								-	-
Delta Connection	Detroit	DTW			499	1,858	1,609	1,510	1,296	912	935	961	26	2.8%			32,795	95,802	80,786	75,507	69,261	51,960	60,782	69,124	8,342	13.7%
Delta Connection	New York J F Kennedy	JFK											-	-											-	-
Delta Connection	New York La Guardia	LGA	727	486			586	1,165	1,140	970	804	789	-15	-1.9%	36,357	24,300			31,216	66,132	63,202	55,968	49,250	48,605	-645	-1.3%
Delta Connection	Minneapolis	MSP											-	-											-	-
Independence Air	Washington Dulles	IAD		1,568									-	-		78,379									-	-
Northwest Airlink	Detroit	DTW											-	-											-	-
Northwest Airlink	Minneapolis	MSP		233									-	-		11,664									-	-
United Express	Chicago O'Hare	ORD		31	1,040	983	867	695	857	779	718	750	32	4.5%		2,170	67,675	62,096	45,929	39,114	49,854	42,976	39,887	39,041	-846	-2.1%
United Express	Cleveland	CLE				935	759	740	111				-	-				46,736	36,046	36,986	5,564				-	-
United Express	New York Newark	EWR				1,391	1,298	1,120	965	1,304	1,284	982	-302	-23.5%				67,250	60,049	54,604	44,824	60,052	59,682	49,324	-10,358	-17.4%
United Express	Washington Dulles	IAD		1,760	1,104	658	427	90					-	-		90,419	55,951	33,514	20,788	5,444					-	-
US Airways Express	Boston	BOS											-	-											-	-
US Airways Express	Charlotte	CLT		307	153	318	366	417					-	-		21,863	13,146	27,181	31,476	32,885					-	-
US Airways Express	New York La Guardia	LGA	2,583	2,499	1,381	1,269	594						-	-	96,936	86,492	49,420	43,737	21,962						-	-
US Airways Express	Philadelphia	PHL		562	2,116	2,068	2,092	2,004					-	-		30,239	140,277	135,156	134,567	126,552					-	-
US Airways Express	Pittsburgh	PIT		1,022									-	-		51,107									-	-
US Airways Express	Washington National	DCA		508	1,039	1,043	1,002	1,252					-	-		25,379	81,095	81,683	78,512	84,499					-	-
Subtotal			**9,655**	**13,788**	**10,716**	**10,925**	**9,600**	**9,045**	**8,417**	**8,084**	**7,869**	**7,673**	**-196**	**-2.5%**	**416,980**	**627,572**	**591,840**	**600,808**	**541,331**	**525,567**	**501,613**	**491,858**	**492,906**	**488,103**	**-4,803**	**-1.0%**
													-	-											-	-
Total			**23,681**	**33,067**	**20,566**	**19,529**	**16,369**	**15,347**	**13,585**	**13,234**	**13,145**	**12,656**	**-489**	**-3.7%**	**2,238,636**	**3,235,907**	**1,903,517**	**1,769,288**	**1,476,919**	**1,433,085**	**1,270,518**	**1,259,058**	**1,284,716**	**1,232,853**	**-51,863**	**-4.0%**

Source: OAG Schedules.

Notes: All Northwest Airlines operations included in Delta Air Lines from 2009 onwards (following 2008 merger).
All Continental Airlines operations included in United Airlines from 2011 onwards (following 2010 merger).
All AirTran Airways operations included in Southwest Airlines from 2012 onwards (following 2011 merger).
All US Airways operations included in American Airlines from 2014 onwards (following 2013 merger).

Table F-6 Scheduled Passenger Operations by Market and Carrier for Portland International Jetport

			Departures												Departing Seats											
Carrier	Market	Code	2000	2005	2010	2011	2012	2013	2014	2015	2016	2017	'16-'17 Change	'16-'17 Pct. Change	2000	2005	2010	2011	2012	2013	2014	2015	2016	2017	'16-'17 Change	'16-'17 Pct. Change
Jet Carriers																										
American	Charlotte	CLT							374	365	487	730	243	49.9%							46,341	45,504	62,336	93,963	31,627	50.7%
American	Philadelphia	PHL							92				-	-							9,108				-	-
American	Washington National	DCA								30	4	22	18	450.0%								3,720	567	2,156	1,589	280.2%
AirTran	Atlanta	ATL			92	167							-	-			10,764	19,522							-	-
AirTran	Baltimore	BWI			944	927							-	-			112,951	109,024							-	-
AirTran	Orlando	MCO			52	52							-	-			6,503	6,355							-	-
Continental	Cleveland	CLE											-	-											-	-
Continental	New York Newark	EWR											-	-											-	-
Delta	Atlanta	ATL	732	486	424	793	751	737	693	714	710	655	-55	-7.7%	103,944	61,229	60,167	114,597	110,397	109,750	103,571	107,000	106,660	99,378	-7,282	-6.8%
Delta	Cincinnati	CVG	1,089	486									-	-	154,658	69,012									-	-
Delta	Detroit	DTW									74	113	39	52.7%									8,124	12,446	4,322	53.2%
Delta	New York La Guardia	LGA					184	239	79	30			-	-					24,256	35,374	11,750	3,300			-	-
Independence Air	Washington Dulles	IAD		307									-	-		40,524									-	-
jetBlue	New York J F Kennedy	JFK			1,201	1,323	1,239	1,307	1,332	1,295	1,198	1,223	25	2.1%			128,936	135,379	124,571	130,671	133,200	130,314	119,800	122,286	2,486	2.1%
jetBlue	Orlando	MCO			212	181							-	-			21,214	21,344							-	-
Northwest	Detroit	DTW	523	427									-	-	52,105	42,700									-	-
Southwest	Baltimore	BWI					1,016	1,005	1,084	1,106	1,175	1,226	51	4.3%					119,112	136,588	152,939	158,358	168,423	183,430	15,007	8.9%
Southwest	Orlando	MCO					13		4	4	4	9	5	125.0%					1,521		633	633	633	1,246	613	96.8%
Southwest	Chicago Midway	MDW							9	9	9	0	-9	-100.0%							1,246	1,246	1,246	0	-1,246	-100.0%
Trans World Airlines	Hartford	BDL	305										-	-	43,310										-	-
United	Chicago O'Hare	ORD	728								66		-66	-100.0%	88,996								8,066		-8,066	-100.0%
United	Manchester	MHT	366										-	-	53,802										-	-
United	New York Newark	EWR									9		-9	-100.0%									1,196		-1,196	-100.0%
United	Washington Dulles	IAD									18		-18	-100.0%									2,657		-2,657	-100.0%

Table F-6 Scheduled Passenger Operations by Market and Carrier for Portland International Jetport (Continued)

			Departures												Departing Seats											
Carrier	Market	Code	2000	2005	2010	2011	2012	2013	2014	2015	2016	2017	'16-'17 Change	'16-'17 Pct. Change	2000	2005	2010	2011	2012	2013	2014	2015	2016	2017	'16-'17 Change	'16-'17 Pct. Change
US Airways	Charlotte	CLT			395	352	366	365					-	-			48,688	47,130	49,044	45,260					-	-
US Airways	Philadelphia	PHL	1,312	154		217	18						-	-	163,051	19,404		21,525	1,895						-	-
US Airways	Pittsburgh	PIT	1,081										-	-	137,472										-	-
US Airways	Washington National	DCA		52									-	-		6,668									-	-
Subtotal			**6,135**	**1,912**	**3,320**	**4,013**	**3,587**	**3,653**	**3,667**	**3,553**	**3,754**	**3,978**	**224**	**6.0%**	**797,338**	**239,537**	**389,224**	**474,876**	**430,796**	**457,644**	**458,788**	**450,075**	**479,708**	**514,905**	**35,197**	**7.3%**
Regional/ Commuter Carriers																										
Air Canada Express	Montreal Dorval	YUL	344										-	-	4,734										-	-
Air Canada Express	Toronto	YYZ			481	783	671	97					-	-			9,142	14,872	12,749	1,741					-	-
America West	New York Newark	EWR	52										-	-	2,457										-	-
American Eagle	Boston	BOS	3,804										-	-	125,518										-	-
American Eagle	Charlotte	CLT							26	143	243	61	-182	-74.9%							2,065	11,666	20,898	4,233	-16,665	-79.7%
American Eagle	Chicago O'Hare	ORD											-	-											-	-
American Eagle	New York La Guardia	LGA	2,033										-	-	67,084										-	-
American Eagle	Philadelphia	PHL							1,986	2,148	2,066	2,066	-	0.0%							125,325	141,789	120,072	118,721	-1,351	-1.1%
American Eagle	Washington National	DCA							1,426	1,613	1,707	1,724	17	1.0%							99,757	107,469	113,463	120,501	7,038	6.2%
Continental Connection	Albany	ALB		291									-	-		5,537									-	-
Continental Connection	Boston	BOS	204	241									-	-	3,871	4,576									-	-
Continental Connection	New York Newark	EWR			1,426								-	-			105,503								-	-
Continental Connection	Presque Isle	PQI											-	-											-	-
Continental Express	Cleveland	CLE	425	223	188								-	-	20,378	11,021	9,400								-	-
Continental Express	New York Newark	EWR	1,429	1,394	4								-	-	70,393	69,605	200								-	-
Delta Connection	Atlanta	ATL		700	350								-	-		48,440	25,532								-	-
Delta Connection	Boston	BOS		1,153									-	-		57,650									-	-

Table F-6 Scheduled Passenger Operations by Market and Carrier for Portland International Jetport (Continued)

			Departures												Departing Seats											
Carrier	Market	Code	2000	2005	2010	2011	2012	2013	2014	2015	2016	2017	'16-'17 Change	'16-'17 Pct. Change	2000	2005	2010	2011	2012	2013	2014	2015	2016	2017	'16-'17 Change	'16-'17 Pct. Change
Delta Connection	Cincinnati	CVG		600									-	-		31,166									-	-
Delta Connection	Detroit	DTW			1,217	1,314	1,264	1,249	1,061	896	840	817	-23	-2.7%			62,320	65,686	64,758	62,436	60,448	59,315	60,354	59,080	-1,274	-2.1%
Delta Connection	New York J F Kennedy	JFK			270								-	-			13,500								-	-
Delta Connection	New York La Guardia	LGA	475	1,095	786	1,034	1,050	1,202	1,231	1,284	1,332	1,561	229	17.2%	15,191	54,750	41,440	57,437	67,453	80,898	80,103	76,325	80,582	100,527	19,945	24.8%
Delta Connection	Minneapolis	MSP											-	-											-	-
Independence Air	Washington Dulles	IAD		1,384									-	-		69,186									-	-
Lufthansa German Airlines	Washington Dulles	IAD	31										-	-	1,550										-	-
Northwest Airlink	Detroit	DTW	484	915									-	-	33,366	53,132									-	-
Northwest Airlink	Minneapolis	MSP		404									-	-		20,186									-	-
Starlink Aviation	Yarmouth	YQI			521	521	217						-	-			9,386	9,386	3,909						-	-
Swissair	Boston	BOS	31										-	-	1,023										-	-
Ulendo Airlink	Bar Harbor	BHB									18		-18	-100.0%									886		-886	-100.0%
Ulendo Airlink	Halifax	YHZ										40	40	-										2,156	2,156	-
Ulendo Airlink	Islip	ISP									18		-18	-100.0%									886		-886	-100.0%
Ulendo Airlink	Melbourne	MLB									83	104	21	25.3%									5,173	5,237	64	1.2%
Ulendo Airlink	Sarasota/ Bradenton	SRQ									17	104	87	511.8%									906	5,763	4,857	536.1%
United Express	Chicago O'Hare	ORD		1,095	1,249	1,176	1,125	1,045	1,038	1,029	964		-964	-100.0%		67,590	82,273	72,457	59,896	65,872	63,099	64,054	53,558		-53,558	-100.0%
United Express	Cleveland	CLE				188	249	298					-	-				9,400	11,906	14,886					-	-
United Express	New York Newark	EWR				1,426	1,596	1,630	1,470	1,779	2,035		-2,035	-100.0%				103,511	81,454	102,156	92,953	108,900	113,044		-113,044	-100.0%
United Express	Washington Dulles	IAD	996	1,456	1,078	1,066	885	750	689	560	572		-572	-100.0%	49,779	83,730	64,767	62,493	43,839	39,624	37,949	35,213	35,764		-35,764	-100.0%
US Airways Express	Bangor	BGR	231										-	-	8,558										-	-
US Airways Express	Boston	BOS	2,229										-	-	42,359										-	-
US Airways Express	Charlotte	CLT		365	88	18	31	35					-	-		23,710	5,323	1,364	2,542	2,777					-	-
US Airways Express	New York La Guardia	LGA	1,218	1,665	1,647	1,526	598						-	-	43,901	77,909	78,477	68,755	26,013						-	-

Table F-6 Scheduled Passenger Operations by Market and Carrier for Portland International Jetport (Continued)

			Departures												Departing Seats											
Carrier	**Market**	**Code**	**2000**	**2005**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**'16-'17 Change**	**'16-'17 Pct. Change**	**2000**	**2005**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**'16-'17 Change**	**'16-'17 Pct. Change**
US Airways Express	Philadelphia	PHL		1,913	1,947	1,987	2,153	2,131					-	-		100,307	133,521	129,133	139,908	137,137					-	-
US Airways Express	Pittsburgh	PIT		219									-	-		10,971									-	-
US Airways Express	Plattsburgh	PLB	48										-	-	909										-	-
US Airways Express	Presque Isle	PQI											-	-											-	-
US Airways Express	Washington National	DCA	1,089	1,149	1,043	1,043	1,260	1,408					-	-	33,976	75,568	83,302	87,190	102,160	100,248					-	-
US Airways Express	Westchester County	HPN	65										-	-	1,235										-	-
Subtotal			15,187	16,261	12,296	12,081	11,098	9,843	8,927	9,452	9,895	6,477	-3,418	-34.5%	526,282	865,033	724,086	681,682	616,586	607,775	561,699	604,731	605,586	416,218	-189,368	-31.3%
Total			21,322	18,174	15,615	16,094	14,684	13,496	12,594	13,005	13,649	10,455	-3,194	-23.4%	1,323,619	1,104,570	1,113,310	1,156,558	1,047,382	1,065,419	1,020,487	1,054,806	1,085,294	931,123	-154,171	-14.2%

Source: OAG Schedules.

Notes: All Northwest Airlines operations included in Delta Air Lines from 2009 onwards (following 2008 merger).
All Continental Airlines operations included in United Airlines from 2011 onwards (following 2010 merger).
All AirTran Airways operations included in Southwest Airlines from 2012 onwards (following 2011 merger).
All US Airways operations included in American Airlines from 2014 onwards (following 2013 merger).

Table F-7 Scheduled Passenger Operations by Market and Carrier for Burlington International Airport

			Departures												Departing Seats											
Carrier	Market	Code	2000	2005	2010	2011	2012	2013	2014	2015	2016	2017	'16-'17 Change	'16-'17 Pct. Change	2000	2005	2010	2011	2012	2013	2014	2015	2016	2017	'16-'17 Change	'16-'17 Pct. Change
Jet Carriers																										
AirTran	Baltimore	BWI											-	-											-	-
Allegiant Air	Orlando/ Sanford	SFB							94	104	95	18	-77	-81.1%							15,873	17,880	16,452	3,065	-13,387	-81.4%
American	Philadelphia	PHL							116				-	-							11,470				-	-
Continental	New York Newark	EWR											-	-											-	-
Delta	Atlanta	ATL						153	92	92	110	341	231	210.0%						21,394	13,708	13,708	15,202	38,852	23,650	155.6%
jetBlue	New York J F Kennedy	JFK	244	1,126	1,434	1,405	1,363	1,365	1,244	1,156	1,182	1,189	7	0.6%	39,528	173,920	180,286	163,839	163,821	143,907	124,357	115,600	118,157	118,871	714	0.6%
jetBlue	Orlando	MCO			330	339	326						-	-			33,014	33,871	32,643						-	-
Northwest	Detroit	DTW		174									-	-		17,429									-	-
United	Chicago O'Hare	ORD	815	365						113	345	202	-143	-41.4%	105,509	42,379						13,777	45,877	27,228	-18,649	-40.6%
United	Portland (ME)	PWM											-	-											-	-
US Airways	Philadelphia	PHL	1,098	365				26					-	-	150,338	46,170				2,546					-	-
US Airways	Pittsburgh	PIT	732										-	-	103,568										-	-
US Airways	Washington National	DCA		4									-	-		558									-	-
Subtotal			2,889	2,035	1,764	1,744	1,690	1,543	1,546	1,465	1,732	1,750	18	1.0%	398,943	280,456	213,300	197,710	196,464	167,847	165,408	160,965	195,688	188,016	-7,672	-3.9%
Regional/ Commuter Carriers																										
America West	New York Newark	EWR	166										-	-	7,889										-	-
American Eagle	Boston	BOS	3,094										-	-	102,111										-	-
American Eagle	Charlotte	CLT								122	378	627	249	65.9%								9,516	29,858	48,996	19,138	64.1%
American Eagle	Chicago O'Hare	ORD											-	-											-	-
American Eagle	New York La Guardia	LGA									18	21	3	16.7%									886	1,064	178	20.1%
American Eagle	Philadelphia	PHL							1,823	1,921	1,933	1,734	-199	-10.3%							110,129	126,772	103,725	103,662	-63	-0.1%
American Eagle	Washington National	DCA							1,276	1,339	1,394	1,386	-8	-0.6%							89,462	86,015	96,228	97,867	1,639	1.7%
Continental Connection	Albany	ALB											-	-											-	-
Continental Connection	Boston	BOS	244	634									-	-	4,628	12,054									-	-
Continental Connection	Buffalo	BUF	4										-	-	84										-	-

Table F-7 Scheduled Passenger Operations by Market and Carrier for Burlington International Airport (Continued)

			Departures												Departing Seats											
Carrier	Market	Code	2000	2005	2010	2011	2012	2013	2014	2015	2016	2017	'16-'17 Change	'16-'17 Pct. Change	2000	2005	2010	2011	2012	2013	2014	2015	2016	2017	'16-'17 Change	'16-'17 Pct. Change
Continental Connection	Hartford	BDL											-	-											-	-
Continental Connection	New York Newark	EWR			405								-	-			30,002								-	-
Continental Connection	Plattsburgh	PLB	213	367									-	-	4,039	6,970									-	-
Continental Connection	Plattsburgh International	PBG											-	-											-	-
Continental Connection	Poughkeepsie	POU	66										-	-	1,262										-	-
Continental Connection	Washington Dulles	IAD											-	-											-	-
Continental Connection	Westchester County	HPN											-	-											-	-
Continental Express	Cleveland	CLE	322	509	366								-	-	16,064	25,351	18,286								-	-
Continental Express	New York Newark	EWR	1,458	1,455	1,020								-	-	70,203	72,707	51,000								-	-
Continental Express	Westchester County	HPN											-	-											-	-
Delta Connection	Atlanta	ATL		62				61	273	273	255	59	-196	-76.9%		3,100				4,636	20,701	20,748	19,369	4,484	-14,885	-76.8%
Delta Connection	Boston	BOS		1,002									-	-		50,100									-	-
Delta Connection	Cincinnati	CVG		1,060									-	-		52,979									-	-
Delta Connection	Detroit	DTW			1,227	1,309	1,282	1,223	1,201	1,004	1,005	1,000	-5	-0.5%			61,417	65,443	64,114	61,224	60,043	57,053	55,842	51,402	-4,440	-8.0%
Delta Connection	New York J F Kennedy	JFK			1,336	1,338	221						-	-			67,071	81,259	14,884						-	-
Delta Connection	New York La Guardia	LGA	355				781	1,279	1,248	1,257	1,151	1,073	-78	-6.8%	11,351				50,144	83,899	82,592	76,339	69,396	60,573	-8,823	-12.7%
Independence Air	Washington Dulles	IAD		1,903									-	-		95,136									-	-
Lufthansa German Airlines	Washington Dulles	IAD	31										-	-	1,550										-	-
Northwest Airlink	Detroit	DTW		1,159									-	-		61,983									-	-
Northwest Airlink	Minneapolis	MSP		61									-	-		3,050									-	-
Porter Airlines	Toronto Island Apt	YTZ				9	31	56	47	39	22	26	4	18.2%				620	2,150	3,910	3,308	2,886	1,607	1,903	296	18.4%
Swissair	Boston	BOS	31										-	-	1,023										-	-
United Express	Chicago O'Hare	ORD		1,003	1,353	1,565	1,391	1,396	1,402	1,144	794	895	101	12.7%		59,930	84,431	88,435	81,204	84,669	85,350	63,845	42,348	50,322	7,974	18.8%
United Express	Cleveland	CLE				348	331	409	73				-	-				17,421	15,376	20,464	3,636				-	-
United Express	New York Newark	EWR				1,425	1,425	1,456	1,281	1,569	1,705	1,710	5	0.3%				94,675	80,261	85,373	82,670	96,340	94,246	89,273	-4,973	-5.3%

Table F-7 Scheduled Passenger Operations by Market and Carrier for Burlington International Airport (Continued)

			Departures												Departing Seats											
Carrier	Market	Code	2000	2005	2010	2011	2012	2013	2014	2015	2016	2017	'16-'17 Change	'16-'17 Pct. Change	2000	2005	2010	2011	2012	2013	2014	2015	2016	2017	'16-'17 Change	'16-'17 Pct. Change
United Express	Washington Dulles	IAD	1,477	1,456	1,130	1,112	1,000	910	892	738	795	815	20	2.5%	73,843	72,786	61,988	69,793	58,665	48,930	50,633	41,127	48,150	47,274	-876	-1.8%
US Airways Express	Boston	BOS	2,404										-	-	48,139										-	-
US Airways Express	Charlotte	CLT											-	-											-	-
US Airways Express	New York La Guardia	LGA	2,074	2,175	1,680	1,487	650						-	-	76,749	80,491	62,144	55,008	24,050						-	-
US Airways Express	Philadelphia	PHL		1,980	1,903	1,956	1,873	1,803					-	-		97,288	128,140	131,727	121,653	111,615					-	-
US Airways Express	Pittsburgh	PIT											-	-											-	-
US Airways Express	Plattsburgh	PLB	2,427										-	-	46,116										-	-
US Airways Express	Poughkeepsie	POU	718										-	-	13,639										-	-
US Airways Express	Saranac Lake	SLK	44										-	-	841										-	-
US Airways Express	Washington National	DCA	988	990	1,043	1,043	1,072	1,347					-	-	31,574	61,458	77,625	82,974	85,623	100,348					-	-
US Airways Express	Wilkes-Barre Scranton	AVP	22										-	-	415										-	-
Subtotal			**16,138**	**15,816**	**11,461**	**11,593**	**10,058**	**9,941**	**9,516**	**9,405**	**9,450**	**9,346**	**-104**	**-1.1%**	**511,521**	**755,382**	**642,104**	**687,357**	**598,123**	**605,069**	**588,524**	**580,640**	**561,655**	**556,820**	**-4,835**	**-0.9%**
Total			**19,028**	**17,851**	**13,225**	**13,336**	**11,748**	**11,484**	**11,062**	**10,870**	**11,182**	**11,096**	**-86**	**-0.8%**	**910,464**	**1,035,838**	**855,404**	**885,067**	**794,588**	**772,916**	**753,932**	**741,605**	**757,343**	**744,836**	**-12,507**	**-1.7%**

Source: OAG Schedules.

Notes: Allegiant stopped reporting to the OAG in 2009, so Allegiant 2009-2015 statistics from the T100 database; 2016-2017 statistics from Innovata SRS.
All Northwest Airlines operations included in Delta Air Lines from 2009 onwards (following 2008 merger).
All Continental Airlines operations included in United Airlines from 2011 onwards (following 2010 merger).
All AirTran Airways operations included in Southwest Airlines from 2012 onwards (following 2011 merger).
All US Airways operations included in American Airlines from 2014 onwards (following 2013 merger).

Table F-8 Scheduled Passenger Operations by Market and Carrier for Bangor International Airport

			Departures												Departing Seats											
Carrier	Market	Code	2000	2005	2010	2011	2012	2013	2014	2015	2016	2017	'16-17 Change	'16-'17 Pct. Change	2000	2005	2010	2011	2012	2013	2014	2015	2016	2017	'16-'17 Change	'16-'17 Pct. Change
Jet Carriers																										
Allegiant Air	Orlando/Sanford	SFB			181	150	156	165	153	180	182	184	2	1.1%			27,150	22,500	23,912	27,335	26,536	31,156	31,730	31,221	-509	-1.6%
Allegiant Air	Punta Gorda	PGD							33	0			-	-							5,478	0			-	-
Allegiant Air	St. Petersburg/ Clearwater	PIE			107	93	112	115	119	134	143	136	-7	-4.9%			16,050	13,950	16,944	19,090	20,501	23,531	25,201	23,926	-1,275	-5.1%
Delta	Detroit	DTW								175	180		-180	-100.0%								19,334	19,769		-19,769	-100.0%
Delta	New York J F Kennedy	JFK										74	74	-										8,171	8,171	-
Pan American Airways	Allentown/ Bethlehem	ABE											-	-											-	-
Pan American Airways	Baltimore	BWI											-	-											-	-
Pan American Airways	Pittsburgh	PIT	285										-	-	42,729										-	-
Pan American Airways	Portsmouth	PSM	389										-	-	58,414										-	-
Pan American Airways	Sanford	SFB											-	-											-	-
Subtotal			674	0	288	243	268	280	305	489	505	394	-111	-22.0%	101,143	0	43,200	36,450	40,856	46,425	52,515	74,021	76,700	63,318	-13,382	-17.4%
Regional/Commuter Carriers																										
American Eagle	Boston	BOS	4,670	1,530									-	-	154,115	56,594									-	-
American Eagle	Charlotte	CLT										13	13	-										828	828	-
American Eagle	New York La Guardia	LGA	382	518							35	44	9	25.7%	12,606	19,166							1,757	3,322	1,565	89.1%
American Eagle	Philadelphia	PHL							1,496	1,452	1,447	1,551	104	7.2%							94,849	91,163	85,549	84,057	-1,492	-1.7%
American Eagle	Washington National	DCA							791	771	900	952	52	5.8%							41,033	40,260	47,737	60,581	12,844	26.9%
Boston-Maine Airways	Halifax	YHZ											-	-											-	-
Boston-Maine Airways	Manchester	MHT											-	-											-	-
Boston-Maine Airways	Portsmouth	PSM											-	-											-	-
Boston-Maine Airways	Saint John	YSJ											-	-											-	-
Continental Connection	Albany	ALB		189									-	-		3,583									-	-
Continental Express	New York Newark	EWR		481									-	-		22,698									-	-
Delta Connection	Atlanta	ATL											-	-											-	-
Delta Connection	Boston	BOS		1,416									-	-		70,800									-	-
Delta Connection	Cincinnati	CVG	1,342	1,394									-	-	67,100	82,439									-	-

Table F-8 Scheduled Passenger Operations by Market and Carrier for Bangor International Airport (Continued)

			Departures												Departing Seats											
Carrier	**Market**	**Code**	**2000**	**2005**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**'16-17 Change**	**'16-'17 Pct. Change**	**2000**	**2005**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**'16-'17 Change**	**'16-'17 Pct. Change**
Delta Connection	Detroit	DTW			975	871	703	706	711	279	204		-204	-100.0%			50,540	54,640	46,260	46,371	47,269	19,614	14,863		-14,863	-100.0%
Delta Connection	New York J F Kennedy	JFK			180							354	354	-			9,000							26,882	26,882	-
Delta Connection	New York La Guardia	LGA			537	844	1,043	1,153	975	976	1,007	1,008	1	0.1%			26,958	49,368	62,868	71,955	59,239	57,025	58,761	60,323	1,562	2.7%
Delta Connection	Minneapolis	MSP											-	-											-	-
Northwest Airlink	Boston	BOS	27										-	-	797										-	-
Northwest Airlink	Detroit	DTW		1,012									-	-		55,222									-	-
Northwest Airlink	Minneapolis	MSP		61									-	-		3,050									-	-
Pan American Airways	Portsmouth	PSM											-	-											-	-
Pan American Airways	Saint John	YSJ											-	-											-	-
United Express	Chicago O'Hare	ORD							245	215	206	280	74	35.9%							16,170	14,190	13,624	19,682	6,058	44.5%
United Express	New York Newark										123	490	367	298.4%									6,150	26,444	20,294	330.0%
US Airways Express	Boston	BOS	1,942										-	-	36,906										-	-
US Airways Express	New York La Guardia	LGA	35	158	1,017	1,230	299						-	-	1,295	7,914	44,051	53,371	14,950						-	-
US Airways Express	Philadelphia	PHL	428	1,179	1,156	1,405	1,543	1,564					-	-	15,836	58,943	68,510	89,548	99,457	101,167					-	-
US Airways Express	Pittsburgh	PIT											-	-											-	-
US Airways Express	Portland (ME)	PWM	231										-	-	8,558										-	-
US Airways Express	Presque Isle	PQI	299										-	-	6,224										-	-
US Airways Express	Washington National	DCA			31	52	589	883					-	-			1,529	2,607	29,464	47,981					-	-
Subtotal			**9,357**	**7,937**	**3,896**	**4,402**	**4,178**	**4,307**	**4,218**	**3,693**	**3,922**	**4,692**	**770**	**19.6%**	**303,436**	**380,408**	**200,587**	**249,535**	**253,000**	**267,474**	**258,560**	**222,252**	**228,441**	**282,119**	**53,678**	**23.5%**
Total			**10,031**	**7,937**	**4,184**	**4,645**	**4,446**	**4,587**	**4,523**	**4,182**	**4,427**	**5,086**	**659**	**14.9%**	**404,579**	**380,408**	**243,787**	**285,985**	**293,856**	**313,899**	**311,075**	**296,273**	**305,141**	**345,437**	**40,296**	**13.2%**

Source: OAG Schedules.

Notes: Allegiant stopped reporting to the OAG in 2009, so Allegiant 2009-2015 statistics from the T100 database; 2016-2017 statistics from Innovata SRS.
All Northwest Airlines operations included in Delta Air Lines from 2009 onwards (following 2008 merger).
All Continental Airlines operations included in United Airlines from 2011 onwards (following 2010 merger).
All AirTran Airways operations included in Southwest Airlines from 2012 onwards (following 2011 merger).
All US Airways operations included in American Airlines from 2014 onwards (following 2013 merger).

Table F-9 Scheduled Passenger Operations by Market and Carrier for Tweed-New Haven Airport

			Departures												Departing Seats											
Carrier	Market	Code	2000	2005	2010	2011	2012	2013	2014	2015	2016	2017	'16-17 Change	'16-'17 Pct. Change	2000	2005	2010	2011	2012	2013	2014	2015	2016	2017	'16-17 Change	'16-'17 Pct. Change
Regional/Commuter Carriers																										
American Eagle	Philadelphia	PHL							1,356	1,222	1,121	1,021	-100	-8.9%							50,161	49,657	63,913	53,712	-10,201	-16.0%
Delta Connection	Cincinnati	CVG		1,025									-	-		51,236									-	-
Boston-Maine Airways	Baltimore	BWI											-	-											-	-
Boston-Maine Airways	Bedford	BED											-	-											-	-
Boston-Maine Airways	Elmira/Corning	ELM											-	-											-	-
Boston-Maine Airways	Portsmouth	PSM											-	-											-	-
US Airways Express	Philadelphia	PHL	1,773	1,904	1,608	1,535	1,381	1,399					-	-	65,612	76,208	59,491	56,806	52,972	51,768					-	-
US Airways Express	Washington National	DCA	937										-	-	34,658										-	-
Total			**2,710**	**2,929**	**1,608**	**1,535**	**1,381**	**1,399**	**1,356**	**1,222**	**1,121**	**1,021**	**-100**	**-8.9%**	**100,270**	**127,444**	**59,491**	**56,806**	**52,972**	**51,768**	**50,161**	**49,657**	**63,913**	**53,712**	**-10,201**	**-16.0%**

Source: OAG Schedules.

Notes: All Northwest Airlines operations included in Delta Air Lines from 2009 onwards (following 2008 merger).
All Continental Airlines operations included in United Airlines from 2011 onwards (following 2010 merger).
All AirTran Airways operations included in Southwest Airlines from 2012 onwards (following 2011 merger).
All US Airways operations included in American Airlines from 2014 onwards (following 2013 merger).

Table F-10 Scheduled Passenger Operations by Market and Carrier for Worcester Regional Airport

			Departures												Departing Seats											
Carrier	Market	Code	2000	2005	2010	2011	2012	2013	2014	2015	2016	2017	'16-'17 Change	'16-'17 Pct. Change	2000	2005	2010	2011	2012	2013	2014	2015	2016	2017	'16-'17 Change	'16-'17 Pct. Change
Jet Carriers																										
Allegiant Air	Sanford	SFB											-	-											-	-
Boston-Maine Airways	Allentown/Bethlehem	ABE											-	-											-	-
Boston-Maine Airways	Portsmouth	PSM											-	-											-	-
Boston-Maine Airways	Sanford	SFB											-	-											-	-
Direct Air	Myrtle Beach	MYR			73	96							-	-			9,782	14,120							-	-
Direct Air	Orlando/Sanford	SFB			144	148							-	-			21,937	24,339							-	-
Direct Air	Punta Gorda	PGD			94	105							-	-			14,541	17,287							-	-
Direct Air	West Palm Beach	PBI			13	51							-	-			1,872	7,444							-	-
jetBlue	Fort Lauderdale/Hollywood	FLL						61	365	365	365	365	-	0.0%						6,100	36,500	36,500	36,500	36,500	-	0.0%
jetBlue	Orlando	MCO						61	365	365	365	365	-	0.0%						6,100	36,500	36,500	36,500	36,500	-	0.0%
Subtotal			0	0	324	400	0	122	730	730	730	730	-	0.0%	0	0	48,132	63,190	0	12,200	73,000	73,000	73,000	73,000	-	0.0%
Regional/Commuter Carriers																										
American Eagle	Chicago O'Hare	ORD											-	-											-	-
American Eagle	New York J F Kennedy	JFK	552										-	-	18,216										-	-
Delta Connection	Atlanta	ATL	670										-	-	33,500										-	-
US Airways Express	Philadelphia	PHL	1,464										-	-	54,168										-	-
Subtotal			**2,686**	**0**	**0**	**0**	**0**	**0**	**0**	**0**			**-**	**-**	**105,884**	**0**	**0**	**0**	**0**	**0**	**0**				**-**	**-**
Total			**2,686**	**0**	**324**	**400**	**0**	**122**	**730**	**730**	**730**	**730**	**-**	**0.0%**	**105,884**	**0**	**48,132**	**63,190**	**0**	**12,200**	**73,000**	**73,000**	**73,000**	**73,000**	**-**	**0.0%**

Source: OAG Schedules.
Notes: All Northwest Airlines operations included in Delta Air Lines from 2009 onwards (following 2008 merger).
All Continental Airlines operations included in United Airlines from 2011 onwards (following 2010 merger).
All AirTran Airways operations included in Southwest Airlines from 2012 onwards (following 2011 merger).
All US Airways operations included in American Airlines from 2014 onwards (following 2013 merger).

Table F-11 Scheduled Passenger Operations by Market and Carrier for Hanscom Field

			Departures												Departing Seats											
Carrier	Market	Code	2000	2005	2010	2011	2012	2013	2014	2015	2016	2017	'16-'17 Change	'16-'17 Pct. Change	2000	2005	2010	2011	2012	2013	2014	2015	2016	2017	'16-'17 Change	'16-'17 Pct. Change
Regional/Commuter Carriers																										
Boston-Maine Airways	Elmira/Corning	ELM											-	-											-	-
Boston-Maine Airways	Hyannis	HYA											-	-											-	-
Boston-Maine Airways	Manchester	MHT											-	-											-	-
Boston-Maine Airways	Martha's Vineyard	MVY											-	-											-	-
Boston-Maine Airways	Nantucket	ACK											-	-											-	-
Boston-Maine Airways	New Haven	HVN											-	-											-	-
Boston-Maine Airways	New London/Groton	GON		9									-	-		159									-	-
Boston-Maine Airways	Portsmouth	PSM		193									-	-		3,482									-	-
Boston-Maine Airways	Trenton	TTN		867									-	-		15,606									-	-
Pan American Airways	Atlantic City Pomona Field	ACY											-	-											-	-
Pan American Airways	Martha's Vineyard	MVY											-	-											-	-
Pan American Airways	New York Newark	EWR											-	-											-	-
Pan American Airways	Portsmouth	PSM											-	-											-	-
Pan American Airways	Westchester County	HPN											-	-											-	-
Shuttle America	Buffalo	BUF	1,119										-	-	55,950										-	-
Shuttle America	Hartford	BDL	173										-	-	8,636										-	-
Shuttle America	New York La Guardia	LGA	523										-	-	26,143										-	-
Shuttle America	Trenton	TTN	2,062										-	-	103,093										-	-
Streamline	Trenton	TTN				155							-	-				4,650							-	-
US Airways	Martha's Vineyard	MVY											-	-											-	-
US Airways	Nantucket	ACK											-	-											-	-
US Airways	New York La Guardia	LGA											-	-											-	-
US Airways	Philadelphia	PHL											-	-											-	-
US Airways	Trenton	TTN											-	-											-	-
US Airways	Westchester County	HPN											-	-											-	-
Total			**3,876**	**1,069**	**0**	**155**	**0**	**0**	**0**	**0**	**0**	**0**	**-**	**-**	**193,821**	**19,247**	**0**	**4,650**	**0**	**0**	**0**	**0**	**0**	**0**	**-**	**-**

Source: OAG Schedules.
Notes: All Northwest Airlines operations included in Delta Air Lines from 2009 onwards (following 2008 merger).
All Continental Airlines operations included in United Airlines from 2011 onwards (following 2010 merger).
All AirTran Airways operations included in Southwest Airlines from 2012 onwards (following 2011 merger).
All US Airways operations included in American Airlines from 2014 onwards (following 2013 merger).

Table F-12 Scheduled Passenger Operations by Market and Carrier for Portsmouth International Airport

Carrier	Market	Code	Departures 2000	2005	2010	2011	2012	2013	2014	2015	2016	2017	'16-'17 Change	'16-'17 Pct. Change	Departing Seats 2000	2005	2010	2011	2012	2013	2014	2015	2016	2017	'16-'17 Change	'16-'17 Pct. Change
Jet Carriers																										
Allegiant Airways	Orlando/Sanford	SFB		35				16	83	95	100	135	35	35.0%		5,229				2,656	14,242	16,111	17,062	22,498	5,436	31.9%
Allegiant Airways	Punta Gorda	PGD							22	35	48	99	51	106.3%							3,652	5,909	8,496	17,496	9,000	105.9%
Allegiant Airways	Fort Lauderdale/Hollywood	FLL								27	43	35	-8	-18.6%								4,779	7,611	6,177	-1,434	-18.8%
Allegiant Airways	St. Petersburg/Clearwater	PIE									13	39	26	200.0%									2,158	6,474	4,316	200.0%
Allegiant Airways	Myrtle Beach	MYR										34	34	-										5,644	5,644	-
Boston-Maine Airways	Fort Lauderdale/Hollywood	FLL		13									-	-		1,993									-	-
Boston-Maine Airways	Hartford	BDL		13									-	-		1,993									-	-
Boston-Maine Airways	Newburgh	SWF		48									-	-		7,179									-	-
Boston-Maine Airways	Sanford	SFB		57									-	-		8,593									-	-
Pan American Airways	Allentown/Bethlehem	ABE	93										-	-	13,950										-	-
Pan American Airways	Bangor	BGR	389										-	-	58,414										-	-
Pan American Airways	Gary	GYY	51										-	-	7,714										-	-
Pan American Airways	Manchester	MHT											-	-											-	-
Pan American Airways	New York Newark	EWR											-	-											-	-
Pan American Airways	Pittsburgh	PIT	261										-	-	39,171										-	-
Pan American Airways	Sanford	SFB	296										-	-	44,400										-	-
Pan American Airways	Santo Domingo	SDQ											-	-											-	-
Pan American Airways	St. Petersburg/Clearwater	PIE											-	-											-	-
Pan American Airways	Worcester	ORH											-	-											-	-
Skybus	Columbus	CMH											-	-											-	-
Skybus	Greensboro	GSO											-	-											-	-
Skybus	Punta Gorda	PGD											-	-											-	-
Skybus	Saint Augustine	UST											-	-											-	-
Subtotal			**1,091**	**167**	**0**	**0**	**0**	**16**	**105**	**157**	**204**		**-204**	**-100.0%**	**163,650**	**24,986**	**0**	**0**	**0**	**2,656**	**17,894**	**26,799**	**35,327**	**58,289**	**22,962**	**65.0%**
Regional/Commuter Carriers																										
Boston-Maine Airways	Baltimore	BWI											-	-											-	-
Boston-Maine Airways	Bangor	BGR											-	-											-	-
Boston-Maine Airways	Bedford	BED		171									-	-		3,083									-	-
Boston-Maine Airways	Hyannis	HYA											-	-											-	-
Boston-Maine Airways	Manchester	MHT											-	-											-	-
Boston-Maine Airways	Martha's Vineyard	MVY											-	-											-	-

Table F-12 Scheduled Passenger Operations by Market and Carrier for Portsmouth International Airport (Continued)

			Departures												Departing Seats											
Carrier	**Market**	**Code**	**2000**	**2005**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**'16-'17 Change**	**'16-'17 Pct. Change**	**2000**	**2005**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**'16-'17 Change**	**'16-'17 Pct. Change**
Boston-Maine Airways	Nantucket	ACK											-	-											-	-
Boston-Maine Airways	New Haven	HVN											-	-											-	-
Boston-Maine Airways	New London/Groton	GON											-	-											-	-
Boston-Maine Airways	Saint John	YSJ											-	-											-	-
Boston-Maine Airways	Trenton	TTN		22									-	-		399									-	-
Boston-Maine Airways	Westchester County	HPN											-	-											-	-
Pan American Airways	Atlantic City Pomona Field	ACY											-	-											-	-
Pan American Airways	Baltimore	BWI											-	-											-	-
Pan American Airways	Bangor	BGR											-	-											-	-
Pan American Airways	Bedford	BED											-	-											-	-
Pan American Airways	Martha's Vineyard	MVY											-	-											-	-
Pan American Airways	Saint John	YSJ											-	-											-	-
Subtotal			**0**	**193**	**0**	**0**	**0**	**0**	**0**	**0**	**0**		**-**	**-**	**0**	**3,482**	**0**	**0**	**0**	**0**	**0**	**0**			**-**	**-**
Total			**1,091**	**360**	**0**	**0**	**0**	**16**	**105**	**157**	**204**		**-204**	**-100.0%**	**163,650**	**28,467**	**0**	**0**	**0**	**2,656**	**17,894**	**26,799**	**35,327**	**58,289**	**22,962**	**65.0%**

Source: OAG Schedules.

Notes: Allegiant stopped reporting to the OAG in 2009, so Allegiant 2009-2015 statistics from the T100 database; 2016-2017 statistics from Innovata SRS.

All Northwest Airlines operations included in Delta Air Lines from 2009 onwards (following 2008 merger).

All Continental Airlines operations included in United Airlines from 2011 onwards (following 2010 merger).

All AirTran Airways operations included in Southwest Airlines from 2012 onwards (following 2011 merger).

All US Airways operations included in American Airlines from 2014 onwards (following 2013 merger).

This Page Intentionally Left Blank.

G

Ground Access to and from Logan Airport

This appendix provides information in support of Chapter 5, *Ground Access to and from Logan Airport*:

- Table G-1A Logan Express Bus Service Ridership (Annual)
- Table G-1B Logan Express Back Bay Service Ridership (Annual)
- Table G-2 Water Transportation Services Ridership to and from Logan Airport (Annual)
- Table G-3 Massachusetts Bay Transportation Authority (MBTA) Airport Station Passengers
- Table G-4 Annual Taxi Dispatches (Tickets Sold)
- Table G-5 On-Airport Commercial Parking Rates, 2010-2017
- Table G-6 Logan Airport Employee Parking Supply
- Table G-7 Logan Airport Commercial Parking Supply
- Table G-8 2017 Existing Conditions – Airport-Related Traffic, On-Airport Link Attributes, Traffic Assignment, and Vehicle Miles Traveled (VMT) Summary
- Table G-9 Future Conditions – Airport-Related Traffic, On-Airport Link Attributes, Traffic Assignment, and Vehicle Miles Traveled (VMT) Summary
- VISSIM Existing Traffic Roadway Network
- VISSIM Future Traffic Roadway Network
- March 2017 Logan Airport Parking Space Inventory, submitted to Massachusetts Department of Environmental Protection (also known as the *Parking Freeze Report*)
- September 2017 Logan Airport Parking Space Inventory, submitted to Massachusetts Department of Environmental Protection (also known as the *Parking Freeze Report*)
- October 2017 Revised Logan Airport Parking Space Inventory, submitted to Massachusetts Department of Environmental Protection (also known as the *Parking Freeze Report*)

This Page Intentionally Left Blank.

Table G-1A Logan Express Bus Service Ridership

	Ridership			Percent Change		
Service Year	**Air Passengers**	**Employees**	**Total**	**Air Passengers**	**Employees**	**Total**
Framingham						
1992	207,847	7,573	215,420	4.3%	21.3%	4.8%
1993	229,064	12,307	241,371	10.2%	62.5%	12.0%
1994	250,342	17,352	267,694	9.3%	41.0%	10.9%
1995	274,754	21,129	295,883	9.8%	21.8%	10.5%
1996	325,665	22,932	348,597	18.5%	8.5%	17.8%
1997	316,306	29,871	346,175	(2.9%)	30.3%	(0.7%)
1998	337,007	33,971	370,978	6.5%	13.7%	7.2%
1999	345,715	31,946	380,661	3.5%	(6.0%)	2.6%
2000	371,560	34,508	406,068	6.6%	8.0%	6.7%
2001	354,521	38,740	393,261	(4.6%)	12.3%	(3.2%)
2002	342,746	42,441	385,187	(3.3%)	8.7%	(2.1%)
2003	310,024	55,979	366,003	(9.5%)	31.9%	(5.0%)
2004	323,931	54,763	378,694	4.5%	(2.2%)	3.5%
2005	318,125	57,569	375,694	(1.8%)	5.1%	(0.8%)
2006	349,022	60,764	409,789	9.7%	5.5%	9.1%
2007	311,299	57,252	368,551	(2.1%)[5]	(0.6%)[5]	(1.9%)[5]
2008	276,112	57,797	333,909	(11.3%)	1.0%	(9.4%)
2009	264,233	59,840	324,073	(4.3%)	3.5%	(2.9%)
2010	272,190	62,226	334,416	3.0%	4.0%	3.2%
2011[1]	272,301	68,228	340,529	0.0%	9.6%	1.8%
2012	279,603	82,951	362,554	2.7%	21.6%	6.5%
2013	295,654	84,008	379,662	5.7%	1.3%	4.7%
2014	303,646	87,488	391,134	2.7%	4.1%	3.0%
2015	345,680	82,943	428,623	13.8%	(5.2%)	9.6%
2016	406,253	92,642	498,895	17.5%	11.7%	16.4%
2017	**434,906**	**99,639**	**534,545**	**7.1%**	**7.6%**	**7.2%**

Table G-1A Logan Express Bus Service Ridership (Continued)

	Ridership			Percent Change		
Service Year	**Air Passengers**	**Employees**	**Total**	**Air Passengers**	**Employees**	**Total**
Braintree						
1992	186,217	9,694	195,911	10.6%	16.6%	10.8%
1993	205,209	22,768	227,977	10.2%	134.9%	16.4%
1994	247,636	37,489	285,125	20.7%	64.7%	25.1%
1995	264,579	70,723	335,302	6.8%	88.7%	17.6%
1996	335,232	103,519	438,751	26.7%	46.4%	30.1%
1997	300,006	135,340	435,346	(10.5%)	30.7%	(0.8%)
1998	300,005	156,105	456,110	0.0%	15.3%	4.8%
1999	328,818	125,286	454,105	9.6%	(19.7%)	(0.5%)
2000	355,932	149,687	505,619	8.2%	19.5%	11.3%
2001	345,249	156,240	501,489	(3.0%)	4.4%	(0.8%)
2002	323,115	190,360	513,475	(6.4%)	21.8%	2.4%
2003	301,013	216,765	517,778	(6.8%)	13.9%	0.8%
2004	318,100	208,566	526,666	5.7%	(3.8%)	1.7%
2005	307,659	189,531	497,190	(3.2%)	(9.1%)	(5.5%)
2006	333,413	202,983	536,396	8.4%	7.1%	7.9%
2007	300,715	196,955	497,670	(2.3%)5	3.9%[5]	0.1%[5]
2008	252,289	221,591	473,880	(16.1%)	12.5%	(4.8%)
2009	231,151	234,908	466,059	(8.4%)	6.0%	(1.7%)
2010	231,422	251,443	482,865	0.1%	7.0%	3.6%
2011[1]	233,521	285,515	519,036	0.9%	13.6%	7.5%
2012	247,346	314,542	561,888	5.9%	10.2%	8.3%
2013	268,154	320,329	588,483	8.4%	1.8%	4.7%
2014	296,975	313,334	610,309	10.7%	(2.2%)	3.7%
2015	313,576	311,695	625,271	5.6%	(0.5%)	2.5%
2016	329,043	326,115	655,158	4.9%	4.6%	4.8%
2017	**345,401**	**349,435**	**694,836**	**5.0%**	**7.2%**	**6.1%**

Table G-1A Logan Express Bus Service Ridership (Continued)

	Ridership			Percent Change		
Service Year	**Air Passengers**	**Employees**	**Total**	**Air Passengers**	**Employees**	**Total**
Woburn[2]						
1992[3]	3,052	91	3,143	NA	NA	-
1993	59,635	5,027	64,662	NA	NA	-
1994	119,567	9,082	128,649	100.5%	80.7%	99.0%
1995	150,147	13,376	163,523	25.6%	47.3%	27.1%
1996	190,566	17,322	207,888	26.9%	29.5%	27.1%
1997	199,715	20,018	219,733	4.8%	15.6%	5.7%
1998	208,286	22,876	231,162	4.3%	14.3%	5.2%
1999	191,454	23,495	214,949	(8.1%)	2.7%	(7.0%)
2000	195,744	27,522	223,266	2.2%	17.1%	3.9%
2001	177,375	38,318	215,530	(9.4%)	39.2%	(3.4%)
2002	161,145	73,277	234,422	(9.2%)	91.0%	8.7%
2003	164,980	103,963	268,943	(2.4%)	41.9%	14.7%
2004	172,110	111,326	283,436	4.3%	7.1%	5.4%
2005	163,227	110,961	274,188	(5.1%)	(0.3%)	(3.2%)
2006	167,341	121,672	289,013	2.5%	9.7%	5.4%
2007	149,149	123,066	272,215	(8.6%)[5]	10.9%[5]	(0.7%)[5]
2008	129,385	122,777	252,162	(13.3%)	(0.2%)	(7.4%)
2009	113,607	121,633	235,240	(12.2%)	(0.9%)	(6.7%)
2010	115,257	127,120	242,377	1.5%	4.5%	3.0%
2011[1]	118,232	151,029	269,261	2.6%	18.8%	11.1%
2012	126,549	188,747	315,296	7.0%	25.0%	17.1%
2013	140,407	192,289	332,696	11.0%	1.9%	5.5%
2014	156,045	194,341	350,386	11.1%	1.1%	5.3%
2015	163,469	191,242	354,711	4.8%	(1.6%)	1.2%
2016	170,704	197,568	368,272	4.4%	3.3%	3.8%
2017	**176,485**	**209,194**	**385,679**	**3.4%**	**5.9%**	**4.7%**

Table G-1A	Logan Express Bus Service Ridership (Continued)					
	Ridership			**Percent Change**		
Service Year	**Air Passengers**	**Employees**	**Total**	**Air Passengers**	**Employees**	**Total**
Peabody						
2001[4]	8,151	3,097	11,248	NA	NA	NA
2002	28,626	20,629	49,255	NA	NA	NA
2003	32,318	23,425	55,743	21.4%	13.6%	13.2%
2004	43,389	33,642	77,031	34.3%	43.6%	38.2%
2005	51,023	39,599	87,622	17.6%	17.7%	13.7%
2006	42,142	32,632	74,774	(17.4%)	(17.6%)	(14.7%)
2007	36,367	26,949	63,316	(28.7%)[5]	(31.9%)[5]	(27.7%)[5]
2008	30,887	30,596	61,483	(15.1%)	13.5%	(2.9%)
2009	27,856	32,220	60,076	(9.8%)	5.3%	(2.3%)
2010	25,543	26,231	51,744	(8.3%)	(18.6%)	(13.8%)
2011[1]	25,555	31,741	57,296	0.0%	21.0%	10.7%
2012	27,542	37,909	65,451	7.8%	19.4%	14.2%
2013	28,790	38,067	66,857	4.5%	0.4%	2.1%
2014	31,485	36,848	68,333	9.4%	(3.2%)	2.2%
2015	37,478	36,125	73,603	19.0%	(2.0%)	7.7%
2016	40,872	36,143	77,015	9.1%	0.0%	4.6%
2017	**46,117**	**37,233**	**83,350**	**12.8%**	**3.0%**	**8.2%**

Table G-1A Logan Express Bus Service Ridership (Continued)

	Ridership			Percent Change		
Service Year	**Air Passengers**	**Employees**	**Total**	**Air Passengers**	**Employees**	**Total**
Total System Ridership						
1992	397,116	17,358	414,474	8.0%	19.2%	8.5%
1993	493,908	39,832	533,740	24.4%	129.5%	28.8%
1994	617,545	63,923	681,468	25.0%	60.5%	27.7%
1995	689,480	105,228	794,708	11.6%	64.6%	16.6%
1996	851,463	143,773	995,236	23.4%	36.6%	25.2%
1997	816,015	185,229	1,001,254	(4.2%)	28.8%	0.6%
1998	845,598	212,952	1,058,550	3.6%	15.0%	5.7%
1999	868,987	180,727	1,049,714	2.7%	(15.2%)	(0.8%)
2000	923,236	211,717	1,134,953	6.2%	17.1%	8.1%
2001	885,296	236,395	1,121,691	(4.1%)	11.7%	(1.2%)
2002	855,632	326,707	1,182,339	(3.4%)	38.2%	5.4%
2003	808,335	400,132	1,208,467	(5.5%)	22.5%	2.2%
2004	857,530	408,297	1,265,827	6.1%	2.0%	2.2%
2005	837,034	397,660	1,234,694	(2.4%)	(2.6%)	(2.4%)
2006	891,918	418,051	1,309,969	6.6%	5.1%	6.1%
2007	797,530	404,222	1,201,752	(4.7%)[5]	1.7%[5]	(2.7%)[5]
2008	688,673	432,761	1,121,434	(13.6%)	7.1%	(6.7%)
2009	636,847	448,601	1,085,448	(7.5%)	3.7%	(3.2%)
2010	644,412	467,020	1,111,432	1.2%	4.1%	2.4%
2011[1]	649,609	536,513	1,186,122	0.8%	14.9%	6.7%
2012	681,040	624,149	1,305,189	4.8%	16.3%	10.0%
2013	733,005	634,693	1,367,698	8.0%	2.0%	5.0%
2014	788,151	632,011	1,420,162	7.5%	(0.4%)	3.8%
2015	860,203	622,005	1,482,208	9.1%	-1.6%	4.4%
2016	946,872	652,468	1,599,340	10.1%	4.9%	7.9%
2017	**1,002,909**	**695,504**	**1,698,410**	**5.9%**	**6.6%**	**6.2%**

Source: Massport.
Notes: January 23, 2008: I-90/Ted Williams Tunnel opens to all traffic.
NA Not applicable.
1 Changes to employee parking and bus fares were implemented in October 2011.
2 Woburn Express moved from Mishawum Station to the Anderson Regional Transportation Center (ARTC) in Woburn in May 2001.
3 Reflects a partial year of operation. Woburn Logan Express service was implemented in November 1992.
4 Reflects a partial year of operation. The Peabody Logan Express service commenced in September 2001.
5 Percent comparison between 2007 and 2005. The I-90 Ted Williams Tunnel closures in 2006 resulted in atypical ridership.

Table G-1B Logan Express Back Bay Service Ridership[1]

	Ridership	Percent Change
Service Year		
2014	152,892	NA
2015	290,796	NA
2016	216,329	(25.6%)
2017	**137,326**	**(36.5%)**

Source: Massport.

1 Back Bay Logan Express service commenced in April 2014. Only total ridership available.

Table G-2	Water Transportation Services Ridership to and from Logan Airport				
	Rowes Wharf/Fan Pier Water Shuttle	**Private Water Taxi (on-demand)**	**Harbor Express (Hingham-Hull-Boston Logan)[1]**	**Boston Logan Water Shuttle (Long Wharf)**	**Total**
1990	181,530	NS	NS	NS	181,530
1991	142,500	NS	NS	NS	142,500
1992	133,297	NS	NS	NS	133,297
1993	159,525	NS	NS	NS	159,525
1994	209,057	NS	NS	NS	209,057
1995	203,829	NS	NS	NS	203,829
1996	159,992	3,364	11,781	NS	175,137
1997	132,542	6,299	71,309	NS	210,150
1998	124,836	9,243	101,174	NS	235,253
1999	122,211	17,252	98,539	NS	238,002
2000	128,097	26,335	83,243	NS	237,675
2001	107,400	29,642	82,704	NS	219,746
2002	75,304	36,736	66,471	NS	178,511
2003	26,480[2]	35,724[3]	61,849	5,722[4]	129,775
2004	NS	54,540	58,788	3,202[5]	116,530
2005	NS	44,975	51,960	NS	96,935
2006	NS	63,639	70,998	NS	134,637
2007	NS	50,737	59,460	NS	110,197
2008	NS	48,630	48,003	NS	96,633
2009	NS	50,734	37,861	NS	88,595
2010	NS	54,382	34,794	NS	89,176
2011	NS	58,879	33,403	NS	92,282
2012	NS	60,840	30,337	NS	91,177
2013	NS	70,378	21,952	NS	92,303
2014	NS	67,479	19,340	NS	86,819
2015	NS	70,798	7,748	NS	78,546
2016	NS	74,788	7,757	NS	82,545
2017	**NS**	**83,689**	**7,424**	**NS**	**91,113**

Source: Massport.
Notes: Figures from 2003 – 2007 have been revised from previous documents.
NS Operation not in service.
1 Service to Quincy was discontinued in 2013 and now operates between Hingham/Hull/Boston (Long Wharf)/Logan.
2 Rowes Wharf Water Shuttle operated from January to June only in 2003.
3 Operated from May to October only in 2003.
4 Long Wharf Boston Logan Water Shuttle operated from August to December in 2003.
5 Joint operation with City Water Taxi began on August 16, 2003.

Table G-3 Massachusetts Bay Transportation Authority (MBTA) Airport Station Passengers

Year	Entrances	Exits	Total Turnstile Count[1]	Percent Change
1990	NA	NA	2,854,317	-
1991	NA	NA	2,515,293	(11.9%)
1992	NA	NA	2,626,572	4.2%
1993	NA	NA	2,604,980	(0.8%)
1994	NA	NA	3,108,734	19.3%
1995	NA	NA	3,040,868	(2.2%)
1996	NA	NA	2,974,850	(2.2%)
1997[2]	NA	NA	2,774,268	(6.7%)
1998	NA	NA	2,850,367	2.7%
1999	NA	NA	2,974,045	4.3%
2000	NA	NA	3,019,086	1.5%
2001	NA	NA	2,896,638	(4.1%)
2002	NA	NA	2,670,594	(7.8%)
2003[3]	1,300,272	1,275,627	2,575,899	(3.6%)
2004	1,373,861	1,366,511	2,740,372	6.4%
2005	NA	NA	NA	NA
2006	NA	NA	NA	NA
2007[4]	1,412,055	--	2,524,079	--
2008[5]	2,212,111	--	3,647,394	56.7%
2009[5]	2,329,370	--	3,750,549	5.3%
2010[5]	2,270,241	--	3,629,193	(2.5%)
2011	2,277,311	NA	NA	0.3%
2012	2,442,085	NA	NA	7.2%
2013	2,597,306	NA	NA	6.3%
2014	2,378,965	NA	NA	(8.4%)[6]
2015	2,122,597	NA	NA	(10.8%)[6]
2016	2,240,744	NA	NA	5.6%
2017	**2,197,783**	**N/A**	**N/A**	**(1.9%)**

Source: MBTA.

Notes: Total Turnstile count figures include both Logan Airport bound (turnstile exits) and non-Logan Airport bound (turnstile entrances) passengers.

NA Data not available

1 As stated in the *Logan Airport 1999 ESPR*, Massport believes that ridership estimates through 2005 from the old Airport Station were understated because many travelers that were destined for the Airport with baggage had been observed to avoid the turnstiles and exit the old Airport Station via the wide gate (designed for handicapped access) that did not have the capability to count passengers.

2 Airport Station was closed on six weekends during September and October 1997 due to construction.

3 Airport Station was closed on eight weekend days during 2003.

4 Automated fare collection and new fare gates implemented beginning January 2007. Station access to Bremen Street Park opened June 2007. Exits are undercounted.

5 Exits are undercounted, as some exits occur through exit doors rather than turnstiles.

6 Due to the closure of Government Center Station in 2014, it is possible that passengers who would normally take the Blue Line to the Green Line switched to alternate modes for their trips.

Table G-4 Annual Taxi Dispatches (Tickets Sold)

Year	Total (yearly tickets sold)	Percent Change
1990	1,330,418	-
1991	1,208,611	(9.2%)
1992	1,266,033	4.8%
1993	1,336,603	5.6%
1994	1,409,505	5.5%
1995	1,499,869	6.4%
1996	1,721,093	14.7%
1997	1,827,244	6.2%
1998	1,888,281	3.3%
1999	1,955,895	3.6%
2000	2,140,724	9.4%
2001	1,789,736	(16.4%)
2002	1,679,508	(6.2%)
2003	1,562,076	(7.0%)
2004	1,713,696	9.7%
2005	1,769,876	3.3%
2006	1,857,609	5.0%
2007	1,925,817	3.7%
2008	1,749,730	(9.1%)
2009	1,630,333	(6.8%)
2010	1,829,961	12.1%
2011	1,937,743	6.0%
2012	2,022,239	4.4%
2013	2,131,371	5.0%
2014	2,237,793	5.0%
2015	2,302,059	2.9%
2016	2,420,391	5.1%
2017	**1,975,174**	**(18.4%)**

Source: Massport.

Table G-5 On-Airport Commercial Parking Rates, 2010-2017

Terminal Area Facility	2010	2011	2012	2013	2014	2015	2016	2017	Economy Parking	2010	2011	2012	2013	2014	2015	2016	2017
Central/West Parking Garage, Terminal B Garage, Terminal E Lots									Economy Parking Garage								
0 to 30 minutes	$3	$3	$3	$3	$3	$3	$3	N/A	Daily Rate	$18	$18	$18	$18	$20	$20	$23	$26
31 minutes to 1 hour	$6	$6	$6	$6	$6	$6	$6	N/A	Additional days 0 to 6 hours	$9	$9	$9	$9	$10	$10	$12	$13
0 minutes to 1 hour							N/A	$7									
1 to 1.5 hours	$9	$9	$9	$9	$11	$10	$12	N/A	Additional days 6 to 24 hours	$18	$18	$18	$18	$20	$20	$23	$26
1.5 to 2 hours	$12	$12	$12	$12	$14	$14	$17	N/A	Weekly Rate (6-7 days)	$108	$108	$108	$108	$120	$120	$138	N/A
1 to 2 hours							N/A	$19									
2 to 3 hours	$15	$15	$17	$17	$19	$19	$22	$24									
3 to 4 hours	$18	$18	$21	$21	$23	$23	$26	$28									
4 to 7 hours	$22	$22	$25	$25	$27	$27	$30	$32									
7 to 24 hours (Daily)	$24	$24	$27	$27	$29	$29	$32	$35									
Additional days 0 to 6 hours	$12	$12	$14	$14	$15	$15	$16	$18									
Additional day(s) 6 to 24 hours	$24	$24	$27	$27	$29	$29	$32	$35									

Source: Massport.

Table G-6 Logan Airport Employee Parking Supply

	Number of Spaces							
Location	**March 2014**	**September 2014**	**March 2015**	**September 2015**	**March 2016**	**September 2016**	**March 2017**	**October 2017**
Terminal Area	857	868	868	865	865	865	**865**	**865**
North Service Area	883	883	881	876	876	876	**876**	**876**
Southwest Service Area	4	4	14	16	16	16	**16**	**16**
South Service Area	681	681	674	665	665	665	**665**	**665**
Airside (Fire/Rescue)	0	0	0	0	0	0	**0**	**0**
Total spaces in service	2,425	2,436	2,437	2,422	2,422	2,422	**2,422**	**2,422**
Total spaces out of service	248	237	236	251	26	26	**26**	**26**
Total employee spaces	2,673	2,673	2,673	2,673	2,448	2,448	**2,448**	**2,448**

Source: Logan Airport Parking Space Inventory submitted to Massachusetts Department of Environmental Protection (MassDEP), March and September 2014, 2015, 2016, and 2017 (September 2017 was revised in October 2017).

Table G-7 Logan Airport Commercial Parking Supply

	Number of Spaces							
Location	**March 2014**	**September 2014**	**March 2015**	**September 2015**	**March 2016**	**September 2016**	**March 2017**	**October 2017**
Terminal Area								
Central Garage and West Garage	10,267	10,267	10,267	10,340	11,954	11,954	**11,954**	**11,954**
Terminal B Garage	2,254	2,254	2,254	2,201	2,212	2,212	**2,212**	**2,212**
Terminal E Lot 1	275	275	243	237	237	237	**237**	**237**
Terminal E Lot 2	248	248	248	249	249	249	**249**	**249**
Terminal E Lot 3 (Gulf Lot)	219	219	219	217	217	217	**217**	**217**
Signature (General Aviation)	35	35	35	35	35	35	**35**	**35**
Logan Airport Hilton	235	235	35	35	235	235	**235**	**235**
North Service Area								
Economy Garage	2,809	2,809	2,809	2,864	2,864	2,864	**2,864**	**2,864**
Overflow Green Lot (Wood Island)	0	0	235	242	0	0	**0**	**0**
South Service Area								
Harborside Hyatt Conference Center and Hotel	270	270	270	270	270	270	**270**	**270**
Overflow Blue Lot (Harborside Dr.)	0	0	315	339	367	367	**367**	**367**
Southwest Service Area								
Overflow Red Lot (Tomahawk Dr.)	0	0	282	282	0	0	**0**	**0**
Massport In-Service Parking Supply (lined spaces)	16,072	16,072	16,872	16,971	**18,100**	**18,100**	**18,100**	**18,100**
Total spaces in service[1]	16,612	16,612	17,212	17,311	18,640	18,640	**18,640**	**18,640**
Total spaces out of service	1,803	1,803	1,203	1,104	-	-	**-**	**5,000**
Total commercial spaces	18,415	18,415	18,415	18,415	18,640	18,640	**18,640**	**23,640**

Source: Logan Airport Parking Space Inventory submitted to MassDEP, March and September 2014, 2015, 2016, and 2017 (September 2017 was revised in October 2017).

1 Total spaces in service includes Signature (General Aviation), Logan Airport Hilton, Harborside Hyatt Conference Center and Hotel, and overflow lots (Overflow Green Lot, Overflow Red Lot, etc.) from previous years.

Table G-8 2017 Existing Conditions – Airport-Related Traffic, On-Airport Link Attributes, Traffic Assignment and Vehicle Miles Traveled (VMT) Summary

Link Name	Link Distance (ft)	Link Speed (mph)	VOLUME				VMT			
			AM Peak	PM Peak	High 8-Hour	AWDT	AM Peak	PM Peak	High 8-Hour	AWDT
1	344	27	973	1187	8567	19422	63.40	77.35	558.24	1265.58
2	496	29	712	869	6270	14215	66.88	81.63	588.96	1335.26
3	1347	20	595	727	5244	11887	151.80	185.48	1337.88	3032.67
4	1166	27	1009	1232	8888	20150	222.81	272.05	1962.63	4449.49
5	378	24	1605	1958	14132	32038	114.98	140.27	1012.39	2295.13
6	441	31	469	572	4131	9364	39.18	47.79	345.14	782.34
7	896	23	1134	1384	9986	22638	192.52	234.97	1695.36	3843.33
8	644	27	1145	1397	10080	22851	139.76	170.52	1230.37	2789.22
9	1214	26	350	427	3080	6983	80.46	98.16	708.01	1605.21
10	1303	25	802	978	7062	16010	197.97	241.41	1743.19	3951.91
11	421	24	545	665	4797	10875	43.46	53.03	382.53	867.22
12	236	31	169	206	1489	3376	7.54	9.20	66.46	150.70
13	1311	31	181	220	1591	3607	44.93	54.61	394.93	895.35
14	750	26	1685	2056	14837	33637	239.35	292.05	2107.58	4778.09
15	441	23	1442	1759	12698	28786	120.40	146.87	1060.25	2403.57
16	1724	23	12	14	102	231	3.92	4.57	33.30	75.43
17	644	19	715	872	6294	14269	87.15	106.28	767.13	1739.14
18	354	26	793	968	6984	15832	53.18	64.92	468.35	1061.71
19	687	15	12	14	102	231	1.56	1.82	13.26	30.03
20	94	15	469	572	4131	9364	8.36	10.20	73.66	166.98
21	877	21	59	72	517	1173	9.80	11.96	85.91	194.92
22	79	32	59	72	517	1173	0.88	1.07	7.70	17.47
23	81	28	12	14	102	231	0.18	0.21	1.56	3.52
24	79	5	11	13	94	213	0.17	0.20	1.41	3.21
25	87	9	9	11	78	178	0.15	0.18	1.28	2.92
26	209	19	9	11	78	178	0.36	0.44	3.09	7.06
27	187	5	11	13	94	213	0.39	0.46	3.33	7.54
28	124	6	20	24	172	391	0.47	0.57	4.05	9.21
29	226	31	348	425	3065	6948	14.90	18.19	131.20	297.42
30	1070	5	522	636	4593	10413	105.74	128.83	930.38	2109.30
31	385	32	279	341	2461	5579	20.33	24.84	179.29	406.45
32	516	26	69	84	604	1368	6.74	8.21	59.04	133.71
34	181	23	410	501	3613	8192	14.03	17.14	123.62	280.30
35	248	26	479	584	4217	9560	22.48	27.41	197.94	448.74
36	89	21	410	501	3613	8192	6.90	8.43	60.82	137.91
37	102	26	69	84	604	1368	1.34	1.63	11.72	26.55

Table G-8 2017 Existing Conditions – Airport-Related Traffic, On-Airport Link Attributes, Traffic Assignment and Vehicle Miles Traveled (VMT) Summary (Continued)

Link Name	Link Distance (ft)	Link Speed (mph)	VOLUME				VMT			
			AM Peak	PM Peak	High 8-Hour	AWDT	AM Peak	PM Peak	High 8-Hour	AWDT
38	110	32	112	137	988	2239	2.33	2.85	20.57	46.61
39	219	31	28	35	251	569	1.16	1.45	10.40	23.58
40	232	9	36	43	314	711	1.58	1.89	13.79	31.24
41	177	26	8	10	71	160	0.27	0.34	2.38	5.36
42	205	29	11	13	94	213	0.43	0.50	3.64	8.26
43	597	26	29	36	259	586	3.28	4.07	29.31	66.31
44	587	32	69	84	604	1368	7.67	9.34	67.14	152.07
45	96	32	65	79	572	1297	1.18	1.44	10.41	23.60
46	112	17	4	4	31	71	0.09	0.09	0.66	1.51
47	859	27	7	9	63	142	1.14	1.46	10.24	23.09
48	94	15	281	343	2477	5615	4.99	6.09	43.95	99.62
49	420	26	289	353	2547	5775	23.01	28.11	202.82	459.87
50	353	33	28	35	251	569	1.87	2.34	16.76	38.00
51	717	26	320	390	2814	6379	43.44	52.95	382.02	866.00
52	403	33	287	350	2524	5722	21.91	26.72	192.71	436.87
53	321	34	5	7	47	107	0.30	0.43	2.85	6.50
54	612	32	292	356	2571	5828	33.84	41.25	297.93	675.35
55	194	26	977	1192	8606	19510	35.84	43.73	315.70	715.71
56	101	8	407	496	3582	8120	7.77	9.47	68.36	154.97
57	97	31	384	469	3386	7676	7.08	8.64	62.41	141.49
58	103	33	0	0	0	0	0.00	0.00	0.00	0.00
59	105	5	0	0	0	0	0.00	0.00	0.00	0.00
60	331	26	954	1164	8402	19048	59.72	72.86	525.92	1192.31
61	224	9	158	192	1387	3145	6.69	8.13	58.71	133.13
62	218	24	223	273	1967	4460	9.23	11.30	81.39	184.55
63	242	23	44	53	384	871	2.02	2.43	17.61	39.95
64	232	5	61	75	541	1226	2.69	3.30	23.81	53.97
65	593	26	1021	1246	8990	20381	114.73	140.01	1010.19	2290.17
66	465	25	17	21	149	338	1.50	1.85	13.11	29.74
67	483	21	4	5	39	89	0.37	0.46	3.57	8.15
68	487	5	0	0	0	0	0.00	0.00	0.00	0.00
69	361	15	9	11	78	178	0.62	0.75	5.33	12.17
90	582	6	948	1157	8347	18924	104.52	127.56	920.24	2086.34
103	85	33	13	16	118	267	0.21	0.26	1.89	4.29
104	85	5	0	0	0	0	0.00	0.00	0.00	0.00
105	95	5	0	0	0	0	0.00	0.00	0.00	0.00
106	95	5	0	0	0	0	0.00	0.00	0.00	0.00

Table G-8 2017 Existing Conditions – Airport-Related Traffic, On-Airport Link Attributes, Traffic Assignment and Vehicle Miles Traveled (VMT) Summary (Continued)

Link Name	Link Distance (ft)	Link Speed (mph)	VOLUME				VMT			
			AM Peak	PM Peak	High 8-Hour	AWDT	AM Peak	PM Peak	High 8-Hour	AWDT
107	260	20	121	148	1066	2417	5.96	7.30	52.54	119.14
108	389	24	76	92	666	1510	5.60	6.78	49.06	111.22
109	114	27	167	204	1474	3341	3.61	4.41	31.84	72.17
110	169	28	167	204	1474	3341	5.34	6.52	47.10	106.76
111	261	5	0	0	0	0	0.00	0.00	0.00	0.00
112	237	30	167	204	1474	3341	7.51	9.17	66.26	150.18
113	565	17	32	39	282	640	3.43	4.18	30.20	68.54
114	609	32	22	27	196	444	2.54	3.11	22.60	51.20
115	451	29	286	349	2516	5704	24.43	29.81	214.91	487.22
116	399	22	32	39	282	640	2.42	2.95	21.31	48.36
117	283	22	42	51	368	835	2.25	2.74	19.74	44.78
118	295	29	299	365	2634	5970	16.70	20.38	147.09	333.37
119	240	12	216	264	1905	4318	9.82	12.00	86.61	196.31
120	365	30	52	63	455	1031	3.60	4.36	31.47	71.30
121	356	17	92	112	807	1830	6.21	7.55	54.44	123.44
122	486	16	75	91	658	1493	6.90	8.37	60.55	137.39
123	486	18	84	102	737	1670	7.72	9.38	67.78	153.58
124	280	25	41	50	361	817	2.17	2.65	19.13	43.30
125	280	19	62	76	549	1244	3.29	4.03	29.09	65.93
126	631	20	123	150	1082	2452	14.70	17.93	129.33	293.08
127	652	24	76	92	666	1510	9.39	11.36	82.26	186.49
128	257	32	21	26	188	426	1.02	1.26	9.15	20.72
129	257	18	33	40	290	657	1.61	1.95	14.11	31.96
130	422	5	0	0	0	0	0.00	0.00	0.00	0.00
131	493	29	6	8	55	124	0.56	0.75	5.13	11.57
132	361	23	139	169	1223	2772	9.50	11.55	83.60	189.48
133	236	27	71	87	627	1422	3.17	3.89	28.01	63.53
134	1521	30	308	376	2712	6148	88.70	108.28	781.02	1770.53
135	1542	27	65	79	572	1297	18.99	23.08	167.09	378.86
136	384	5	0	0	0	0	0.00	0.00	0.00	0.00
137	354	18	4	5	39	89	0.27	0.34	2.62	5.97
138	225	23	13	16	118	267	0.55	0.68	5.02	11.35
139	96	14	13	16	118	267	0.24	0.29	2.15	4.87
140	295	27	65	79	572	1297	3.63	4.41	31.95	72.45
142	257	29	268	327	2359	5348	13.03	15.89	114.65	259.93
144	518	9	288	352	2540	5757	28.23	34.50	248.97	564.29
145	195	22	77	93	674	1528	2.85	3.44	24.94	56.54

Table G-8 2017 Existing Conditions – Airport-Related Traffic, On-Airport Link Attributes, Traffic Assignment and Vehicle Miles Traveled (VMT) Summary (Continued)

Link Name	Link Distance (ft)	Link Speed (mph)	VOLUME				VMT			
			AM Peak	PM Peak	High 8-Hour	AWDT	AM Peak	PM Peak	High 8-Hour	AWDT
146	463	22	77	93	674	1528	6.75	8.15	59.08	133.93
147	230	22	327	399	2877	6521	14.26	17.40	125.47	284.39
148	794	22	38	47	337	764	5.71	7.06	50.65	114.83
149	661	21	98	119	862	1955	12.27	14.90	107.91	244.73
150	281	21	100	122	878	1990	5.32	6.49	46.73	105.92
151	360	21	56	68	494	1119	3.82	4.63	33.66	76.24
152	88	32	0	0	0	0	0.00	0.00	0.00	0.00
153	66	31	44	53	384	871	0.55	0.66	4.79	10.88
154	173	33	44	53	384	871	1.44	1.74	12.59	28.56
155	258	30	310	378	2728	6184	15.17	18.50	133.54	302.71
156	645	26	214	261	1881	4265	26.12	31.86	229.62	520.65
157	218	22	96	117	847	1919	3.96	4.83	34.95	79.19
158	185	24	435	531	3833	8689	15.26	18.63	134.46	304.80
159	354	17	530	647	4671	10590	35.56	43.41	313.36	710.45
160	470	28	39	48	345	782	3.47	4.27	30.68	69.54
161	94	15	253	308	2226	5046	4.52	5.50	39.78	90.17
162	50	15	2	2	16	36	0.02	0.02	0.15	0.34
163	66	15	251	306	2210	5011	3.16	3.85	27.80	63.04
164	367	33	61	75	541	1226	4.24	5.22	37.63	85.27
165	124	26	116	141	1019	2310	2.72	3.30	23.87	54.10
166	84	26	100	122	878	1990	1.60	1.95	14.03	31.81
167	956	26	101	123	886	2008	18.29	22.27	160.42	363.57
168	380	15	36	45	321	729	2.59	3.24	23.08	52.43
169	293	12	137	167	1207	2736	7.61	9.28	67.05	151.98
170	205	33	16	20	141	320	0.62	0.78	5.47	12.41
171	158	5	0	0	0	0	0.00	0.00	0.00	0.00
172	180	5	0	0	0	0	0.00	0.00	0.00	0.00
173	48	5	0	0	0	0	0.00	0.00	0.00	0.00
174	502	10	468	571	4123	9346	44.47	54.25	391.75	888.02
175	640	9	452	552	3982	9027	54.79	66.91	482.68	1094.22
176	319	22	1509	1841	13285	30118	91.04	111.07	801.52	1817.10
177	286	22	1509	1841	13285	30118	81.76	99.75	719.83	1631.91
178	353	18	1040	1270	9163	20772	69.62	85.02	613.38	1390.51
179	348	32	719	877	6333	14357	47.34	57.75	417.00	945.35
180	366	18	961	1173	8465	19191	66.61	81.31	586.75	1330.23
181	453	8	54	66	478	1084	4.63	5.66	41.00	92.98
182	119	8	239	291	2101	4762	5.37	6.53	47.16	106.90

Table G-8 2017 Existing Conditions – Airport-Related Traffic, On-Airport Link Attributes, Traffic Assignment and Vehicle Miles Traveled (VMT) Summary (Continued)

Link Name	Link Distance (ft)	Link Speed (mph)	VOLUME				VMT			
			AM Peak	PM Peak	High 8-Hour	AWDT	AM Peak	PM Peak	High 8-Hour	AWDT
183	50	8	218	266	1920	4353	2.06	2.52	18.17	41.19
184	54	8	37	46	329	746	0.38	0.47	3.34	7.57
185	62	8	69	84	604	1368	0.81	0.98	7.07	16.01
186	39	8	117	143	1035	2346	0.87	1.06	7.69	17.42
187	338	5	184	225	1622	3678	11.77	14.39	103.76	235.27
188	92	12	5	7	47	107	0.09	0.12	0.82	1.87
189	171	5	0	0	0	0	0.00	0.00	0.00	0.00
190	193	13	14	17	125	284	0.51	0.62	4.56	10.37
191	169	5	0	0	0	0	0.00	0.00	0.00	0.00
192	540	5	49	60	431	977	5.02	6.14	44.11	100.00
193	138	9	444	542	3911	8867	11.59	14.15	102.08	231.43
194	932	21	434	530	3825	8671	76.58	93.52	674.95	1530.06
195	79	10	181	220	1591	3607	2.72	3.31	23.91	54.20
196	49	10	456	556	4013	9098	4.20	5.12	36.98	83.83
197	83	5	455	555	4005	9080	7.19	8.78	63.33	143.58
198	692	5	513	626	4515	10235	67.24	82.05	591.77	1341.47
199	70	27	457	558	4029	9133	6.08	7.43	53.63	121.56
200	158	5	0	0	0	0	0.00	0.00	0.00	0.00
201	160	5	64	78	564	1279	1.94	2.36	17.06	38.68
202	335	22	65	79	572	1297	4.12	5.01	36.28	82.26
203	30	5	0	0	0	0	0.00	0.00	0.00	0.00
204	2022	8	117	143	1035	2346	44.80	54.76	396.31	898.30
205	71	26	554	677	4883	11070	7.48	9.14	65.95	149.52
206	142	26	435	531	3833	8689	11.72	14.31	103.29	234.15
207	859	33	262	319	2304	5224	42.61	51.88	374.71	849.61
208	284	32	190	231	1669	3785	10.22	12.42	89.77	203.58
209	80	18	948	1157	8347	18924	14.43	17.61	127.05	288.05
210	71	11	962	1174	8473	19208	13.01	15.87	114.57	259.73
211	390	18	1137	1388	10017	22709	83.95	102.48	739.58	1676.66
212	117	18	624	761	5494	12456	13.86	16.90	121.99	276.57
213	1344	22	1444	1761	12713	28821	367.69	448.41	3237.14	7338.75
214	449	32	984	1201	8669	19653	83.63	102.08	736.80	1670.37
215	1110	32	124	151	1089	2470	26.06	31.73	228.85	519.06
216	905	32	345	421	3041	6894	59.16	72.20	521.49	1182.23
217	1050	32	360	439	3167	7179	71.58	87.29	629.75	1427.52
218	581	25	837	1022	7376	16721	92.06	112.40	811.25	1839.05
219	1063	32	282	344	2485	5633	56.80	69.28	500.49	1134.50

Table G-8 2017 Existing Conditions – Airport-Related Traffic, On-Airport Link Attributes, Traffic Assignment and Vehicle Miles Traveled (VMT) Summary (Continued)

Link Name	Link Distance (ft)	Link Speed (mph)	VOLUME				VMT			
			AM Peak	PM Peak	High 8-Hour	AWDT	AM Peak	PM Peak	High 8-Hour	AWDT
220	415	32	281	343	2477	5615	22.08	26.95	194.64	441.22
221	698	33	0	0	0	0	0.00	0.00	0.00	0.00
222	1920	29	25	30	219	498	9.09	10.91	79.65	181.13
223	1564	28	1118	1364	9845	22318	331.13	403.99	2915.90	6610.16
224	377	29	561	684	4938	11194	40.10	48.89	352.93	800.07
225	551	29	236	288	2077	4709	24.63	30.05	216.73	491.37
226	788	33	84	102	737	1670	12.54	15.22	109.99	249.23
227	1303	33	314	383	2767	6272	77.46	94.49	682.63	1547.32
228	580	30	968	1182	8528	19333	106.39	129.91	937.29	2124.84
229	1653	31	354	432	3120	7072	110.82	135.23	976.69	2213.84
230	2058	29	614	749	5408	12261	239.33	291.95	2107.93	4779.10
231	1300	20	1227	1498	10809	24503	302.01	368.72	2660.53	6031.18
232	736	26	668	816	5886	13345	93.08	113.71	820.18	1859.56
233	488	28	650	793	5722	12971	60.08	73.30	528.88	1198.90
234	449	28	373	455	3284	7445	31.71	38.69	279.22	633.00
235	310	14	333	406	2931	6646	19.55	23.83	172.06	390.14
236	310	11	40	49	353	800	2.35	2.88	20.76	47.04
237	105	5	359	438	3159	7161	7.15	8.73	62.96	142.71
238	697	31	122	149	1074	2434	16.10	19.66	141.69	321.11
239	186	22	59	72	517	1173	2.07	2.53	18.17	41.23
240	145	10	145	177	1278	2896	3.99	4.87	35.18	79.72
241	578	10	204	249	1795	4069	22.35	27.28	196.66	445.80
242	125	20	156	190	1372	3110	3.69	4.49	32.43	73.52
243	564	20	155	189	1364	3092	16.55	20.18	145.67	330.21
244	88	20	122	149	1074	2434	2.02	2.47	17.80	40.34
245	48	13	34	41	298	675	0.31	0.37	2.68	6.07
246	175	5	174	213	1536	3483	5.77	7.06	50.90	115.42
247	65	6	4	4	31	71	0.05	0.05	0.38	0.88
248	39	5	336	409	2955	6699	2.47	3.00	21.70	49.19
249	128	5	151	185	1332	3021	3.65	4.48	32.23	73.11
250	484	5	168	205	1481	3358	15.42	18.81	135.89	308.12
251	388	32	28	35	251	569	2.06	2.57	18.46	41.84
252	308	11	320	390	2814	6379	18.69	22.78	164.40	372.67
253	54	5	11	13	94	213	0.11	0.13	0.96	2.17
254	51	5	0	0	0	0	0.00	0.00	0.00	0.00
255	290	31	4	4	31	71	0.22	0.22	1.71	3.91
256	377	31	37	46	329	746	2.64	3.29	23.50	53.29

Table G-8 2017 Existing Conditions – Airport-Related Traffic, On-Airport Link Attributes, Traffic Assignment and Vehicle Miles Traveled (VMT) Summary (Continued)

Link Name	Link Distance (ft)	Link Speed (mph)	VOLUME				VMT			
			AM Peak	PM Peak	High 8-Hour	AWDT	AM Peak	PM Peak	High 8-Hour	AWDT
257	215	31	22	27	196	444	0.90	1.10	7.99	18.09
258	321	10	68	83	596	1350	4.13	5.04	36.22	82.04
259	203	10	27	33	235	533	1.04	1.27	9.02	20.45
260	362	10	26	31	227	515	1.78	2.12	15.54	35.27
261	219	31	23	28	204	462	0.96	1.16	8.47	19.19
262	218	11	6	8	55	124	0.25	0.33	2.27	5.11
263	177	16	60	73	525	1191	2.01	2.44	17.57	39.86
264	157	5	0	0	0	0	0.00	0.00	0.00	0.00
265	2458	28	85	103	745	1688	39.57	47.95	346.80	785.77
266	752	28	117	142	1027	2328	16.66	20.22	146.26	331.55
267	1323	28	191	233	1685	3820	47.84	58.37	422.09	956.89
268	1252	31	335	408	2947	6681	79.41	96.71	698.57	1583.69
269	302	29	20	24	172	391	1.15	1.37	9.85	22.40
270	1005	17	883	1077	7775	17627	168.06	204.99	1479.83	3354.99
271	954	15	470	573	4138	9382	84.90	103.50	747.46	1694.69
272	656	23	492	601	4334	9826	61.13	74.68	538.53	1220.94
273	485	7	512	624	4507	10217	47.04	57.33	414.07	938.67
274	1244	27	135	165	1191	2701	31.81	38.87	280.61	636.37
275	419	5	0	0	0	0	0.00	0.00	0.00	0.00
276	649	27	125	153	1105	2505	15.36	18.80	135.78	307.80
277	2473	25	91	111	799	1812	42.63	52.00	374.29	848.84
278	573	32	390	476	3433	7783	42.34	51.67	372.68	844.90
279	458	21	243	296	2140	4851	21.07	25.66	185.53	420.56
280	295	25	177	216	1560	3536	9.90	12.08	87.21	197.68
281	440	21	174	212	1528	3465	14.49	17.65	127.21	288.47
282	76	21	116	141	1019	2310	1.68	2.04	14.75	33.44
283	697	21	294	358	2587	5864	38.78	47.23	341.27	773.56
284	690	20	624	761	5494	12456	81.49	99.38	717.50	1626.73
285	91	20	701	856	6176	14002	12.08	14.75	106.39	241.21
286	464	20	1033	1261	9100	20630	90.79	110.83	799.84	1813.26
287	229	29	1029	1255	9061	20541	44.66	54.47	393.28	891.56
288	500	10	1030	1257	9069	20559	97.45	118.92	857.99	1945.03
289	738	26	2246	2741	19783	44849	313.95	383.14	2765.30	6269.06
290	190	27	1887	2302	16617	37670	67.81	82.73	597.17	1353.76
291	494	32	515	629	4538	10288	48.21	58.88	424.80	963.06
292	689	26	1371	1674	12078	27382	178.80	218.31	1575.12	3570.94
293	325	29	1454	1775	12807	29035	89.52	109.28	788.48	1787.57

Table G-8 2017 Existing Conditions – Airport-Related Traffic, On-Airport Link Attributes, Traffic Assignment and Vehicle Miles Traveled (VMT) Summary (Continued)

Link Name	Link Distance (ft)	Link Speed (mph)	VOLUME				VMT			
			AM Peak	PM Peak	High 8-Hour	AWDT	AM Peak	PM Peak	High 8-Hour	AWDT
294	396	25	327	399	2877	6521	24.55	29.95	215.96	489.49
295	1017	30	1128	1376	9931	22513	217.30	265.07	1913.11	4336.92
296	162	19	358	437	3151	7143	10.99	13.42	96.76	219.36
297	140	19	358	437	3151	7143	9.48	11.58	83.48	189.23
298	951	12	268	327	2359	5348	48.29	58.92	425.03	963.57
299	805	14	356	434	3135	7108	54.28	66.18	478.02	1083.82
300	518	16	66	80	580	1315	6.48	7.85	56.93	129.07
301	749	7	126	154	1113	2523	17.88	21.85	157.92	357.98
302	652	15	327	399	2877	6521	40.38	49.27	355.26	805.22
303	547	5	120	147	1058	2399	12.42	15.22	109.53	248.37
304	406	13	31	38	274	622	2.38	2.92	21.06	47.82
305	442	5	149	181	1309	2967	12.48	15.16	109.62	248.48
306	207	5	180	219	1583	3589	7.06	8.59	62.09	140.76
307	70	5	302	368	2657	6024	4.00	4.88	35.23	79.88
308	319	13	63	77	556	1262	3.81	4.65	33.60	76.26
309	281	7	71	87	627	1422	3.78	4.63	33.36	75.65
310	555	27	829	1011	7297	16543	87.07	106.18	766.39	1737.48
311	208	17	829	1011	7297	16543	32.66	39.83	287.46	651.69
312	125	17	1479	1805	13027	29532	35.01	42.73	308.40	699.15
313	332	27	808	986	7117	16134	50.85	62.06	447.93	1015.45
314	440	27	1177	1436	10362	23491	98.13	119.72	863.89	1958.47
315	215	16	773	943	6803	15423	31.48	38.41	277.07	628.13
316	543	17	103	126	909	2061	10.60	12.96	93.52	212.03
317	180	14	166	203	1466	3323	5.66	6.92	49.98	113.29
318	221	11	166	203	1466	3323	6.94	8.49	61.28	138.91
319	2544	9	246	300	2163	4904	118.52	144.54	1042.11	2362.68
320	552	12	73	89	643	1457	7.63	9.30	67.18	152.23
321	628	14	316	386	2782	6308	37.60	45.93	331.06	750.65
322	181	12	369	451	3253	7374	12.65	15.46	111.53	252.83
323	58	12	344	419	3025	6859	3.80	4.63	33.39	75.71
324	387	13	1	1	8	18	0.07	0.07	0.59	1.32
325	406	12	344	420	3033	6877	26.43	32.27	233.03	528.38
326	89	5	53	64	462	1048	0.89	1.08	7.76	17.60
327	463	13	488	595	4295	9737	42.79	52.18	376.64	853.87
328	79	16	538	656	4734	10732	8.06	9.82	70.89	160.71
329	103	16	538	656	4734	10732	10.45	12.75	91.99	208.55
330	323	13	28	34	243	551	1.71	2.08	14.86	33.69

Table G-8 2017 Existing Conditions – Airport-Related Traffic, On-Airport Link Attributes, Traffic Assignment and Vehicle Miles Traveled (VMT) Summary (Continued)

Link Name	Link Distance (ft)	Link Speed (mph)	VOLUME				VMT			
			AM Peak	PM Peak	High 8-Hour	AWDT	AM Peak	PM Peak	High 8-Hour	AWDT
331	179	11	239	291	2101	4762	8.10	9.86	71.20	161.38
332	993	5	396	483	3488	7907	74.46	90.82	655.85	1486.76
333	384	10	2	2	16	36	0.15	0.15	1.16	2.62
334	366	24	318	388	2798	6344	22.02	26.87	193.77	439.34
335	583	29	748	912	6584	14926	82.59	100.70	726.96	1648.02
336	428	27	1257	1533	11067	25090	101.96	124.34	897.65	2035.06
337	94	5	222	270	1952	4424	3.96	4.82	34.84	78.95
338	366	5	121	148	1066	2417	8.38	10.25	73.85	167.45
339	311	5	93	114	823	1866	5.47	6.71	48.41	109.75
340	273	20	4	5	39	89	0.21	0.26	2.01	4.60
341	66	16	4	4	31	71	0.05	0.05	0.39	0.88
342	48	29	1	1	8	18	0.01	0.01	0.07	0.16
343	52	22	53	64	462	1048	0.52	0.63	4.55	10.32
344	82	12	22	27	196	444	0.34	0.42	3.05	6.91
345	25	5	52	63	455	1031	0.25	0.30	2.15	4.88
346	121	5	53	65	470	1066	1.21	1.48	10.73	24.34
347	303	7	76	92	666	1510	4.36	5.28	38.21	86.63
348	146	22	428	522	3770	8547	11.85	14.45	104.36	236.59
349	67	22	239	291	2101	4762	3.02	3.68	26.56	60.20
350	446	5	239	292	2108	4780	20.18	24.65	177.96	403.54
351	335	5	34	41	298	675	2.16	2.61	18.93	42.89
352	430	5	137	167	1207	2736	11.15	13.59	98.22	222.63
353	360	5	51	62	447	1013	3.47	4.22	30.44	68.97
354	50	8	77	93	674	1528	0.73	0.88	6.38	14.47
355	88	13	239	291	2101	4762	3.99	4.86	35.09	79.52
356	113	13	428	522	3770	8547	9.16	11.18	80.71	182.98
358	463	5	0	0	0	0	0.00	0.00	0.00	0.00
359	229	12	3	3	24	53	0.13	0.13	1.04	2.30
360	245	13	2	2	16	36	0.09	0.09	0.74	1.67
361	248	17	37	46	329	746	1.74	2.16	15.44	35.01
362	199	9	35	42	306	693	1.32	1.58	11.54	26.14
363	230	22	40	49	353	800	1.74	2.13	15.36	34.82
364	256	19	36	45	321	729	1.75	2.18	15.57	35.37
365	201	23	16	20	141	320	0.61	0.76	5.36	12.17
366	201	10	78	96	690	1564	2.97	3.66	26.29	59.60
367	337	32	704	859	6200	14055	44.94	54.84	395.79	897.24
368	868	11	387	472	3410	7730	63.65	77.63	560.86	1271.38

Table G-8 2017 Existing Conditions – Airport-Related Traffic, On-Airport Link Attributes, Traffic Assignment and Vehicle Miles Traveled (VMT) Summary (Continued)

Link Name	Link Distance (ft)	Link Speed (mph)	VOLUME				VMT			
			AM Peak	PM Peak	High 8-Hour	AWDT	AM Peak	PM Peak	High 8-Hour	AWDT
369	167	15	369	451	3253	7374	11.70	14.30	103.12	233.76
370	96	15	250	305	2202	4993	4.53	5.53	39.89	90.46
371	141	20	668	816	5886	13345	17.83	21.78	157.09	356.16
372	283	29	431	526	3794	8600	23.09	28.18	203.24	460.70
373	283	27	209	255	1842	4176	11.20	13.66	98.68	223.71
			LOGAN AIRPORT VMT				**9,844**	**12,009**	**86,678**	**196,503**

Source: VHB.
Notes: AWDT = Average annual weekday daily traffic.

Table G-9 Future Conditions – Airport-Related Traffic, On-Airport Link Attributes, Traffic Assignment and Vehicle Miles Traveled (VMT) Summary

Link Name	Link Distance (ft)	Link Speed (mph)	VOLUME				VMT			
			AM Peak	PM Peak	High 8-Hour	AWDT	AM Peak	PM Peak	High 8-Hour	AWDT
1	344	24	1235	1508	10883	24671	80.48	98.26	709.16	1607.61
2	496	28	776	948	6841	15507	72.89	89.05	642.60	1456.62
3	1347	22	551	673	4857	11010	140.57	171.70	1239.14	2808.93
4	1166	28	867	1059	7640	17319	191.45	233.85	1687.05	3824.35
5	378	27	1418	1731	12490	28313	101.58	124.01	894.76	2028.28
6	441	31	400	488	3522	7984	33.42	40.77	294.26	667.05
7	896	25	1021	1247	8998	20397	173.34	211.71	1527.62	3462.87
8	644	30	1139	1391	10038	22756	139.03	169.79	1225.25	2777.62
9	1214	30	528	645	4653	10549	121.37	148.27	1069.60	2424.93
10	1303	25	693	846	6109	13849	171.06	208.83	1507.95	3418.49
11	421	24	883	1077	7776	17627	70.41	85.88	620.09	1405.65
12	236	22	67	82	588	1334	2.99	3.66	26.25	59.55
13	1311	26	67	82	588	1334	16.63	20.35	145.96	331.13
14	750	26	2012	2456	17724	40178	285.80	348.87	2517.67	5707.23
15	441	24	908	1109	8002	18140	75.82	92.60	668.15	1514.65
16	1724	5	0	0	0	0	0.00	0.00	0.00	0.00
17	644	13	954	1164	8402	19046	116.28	141.87	1024.06	2321.38
18	354	27	614	749	5408	12259	41.18	50.23	362.67	822.10
19	687	23	79	96	694	1573	10.27	12.48	90.23	204.52
20	94	15	1120	1367	9865	22363	19.97	24.38	175.91	398.78
21	877	5	0	0	0	0	0.00	0.00	0.00	0.00
22	79	5	0	0	0	0	0.00	0.00	0.00	0.00
23	81	5	0	0	0	0	0.00	0.00	0.00	0.00
24	79	5	0	0	0	0	0.00	0.00	0.00	0.00
25	87	5	0	0	0	0	0.00	0.00	0.00	0.00
26	209	5	0	0	0	0	0.00	0.00	0.00	0.00
27	187	5	0	0	0	0	0.00	0.00	0.00	0.00
28	No longer in service									
29	226	31	68	84	603	1368	2.91	3.60	25.81	58.56
30	1070	7	409	500	3605	8172	82.85	101.28	730.24	1655.35
31	385	5	0	0	0	0	0.00	0.00	0.00	0.00
32	516	31	68	84	603	1368	6.65	8.21	58.94	133.71
34	181	5	0	0	0	0	0.00	0.00	0.00	0.00
35	248	31	68	84	603	1368	3.19	3.94	28.30	64.21
36	89	5	0	0	0	0	0.00	0.00	0.00	0.00

Table G-9 Future Conditions – Airport-Related Traffic, On-Airport Link Attributes, Traffic Assignment and Vehicle Miles Traveled (VMT) Summary (Continued)

Link Name	Link Distance (ft)	Link Speed (mph)	VOLUME				VMT			
			AM Peak	PM Peak	High 8-Hour	AWDT	AM Peak	PM Peak	High 8-Hour	AWDT
37	102	31	68	84	603	1368	1.32	1.63	11.70	26.55
38	110	32	412	503	3628	8224	8.58	10.47	75.53	171.21
39	219	31	30	37	264	598	1.24	1.53	10.94	24.78
40	232	9	37	45	324	735	1.63	1.98	14.23	32.29
41	177	24	8	9	68	154	0.27	0.30	2.28	5.16
42	205	29	10	13	91	205	0.39	0.50	3.53	7.95
43	597	31	28	34	249	564	3.17	3.85	28.18	63.82
44	587	32	366	447	3228	7318	40.69	49.69	358.83	813.49
45	96	32	62	76	551	1248	1.13	1.38	10.02	22.70
46	112	17	3	4	30	68	0.06	0.09	0.64	1.45
47	859	32	307	375	2708	6138	49.92	60.97	440.32	998.03
48	94	15	268	327	2361	5351	4.75	5.80	41.89	94.93
49	420	26	575	702	5068	11489	45.79	55.90	403.57	914.88
50	353	33	27	33	241	547	1.80	2.20	16.09	36.53
51	717	26	601	734	5294	12002	81.59	99.65	718.70	1629.36
52	403	33	275	335	2421	5488	21.00	25.58	184.84	419.01
53	321	35	5	6	45	103	0.30	0.36	2.73	6.25
54	612	32	278	340	2451	5557	32.21	39.40	284.02	643.94
55	300	12	890	1087	7844	17781	50.57	61.76	445.68	1010.28
56	87	5	0	0	0	0	0.00	0.00	0.00	0.00
57	87	5	0	0	0	0	0.00	0.00	0.00	0.00
58	176	12	894	1091	7874	17849	29.80	36.37	262.49	595.02
59	135	26	618	754	5445	12344	15.81	19.28	139.26	315.70
60	112	5	0	0	0	0	0.00	0.00	0.00	0.00
61	112	5	0	0	0	0	0.00	0.00	0.00	0.00
62	64	30	117	143	1033	2342	1.42	1.73	12.52	28.39
63	62	33	123	150	1086	2462	1.44	1.76	12.75	28.90
64	103	5	0	0	0	0	0.00	0.00	0.00	0.00
65	105	5	0	0	0	0	0.00	0.00	0.00	0.00
66	465	25	15	18	128	291	1.32	1.58	11.26	25.61
67	483	21	4	5	38	85	0.37	0.46	3.48	7.78
68	312	31	0	0	0	0	0.00	0.00	0.00	0.00
69	361	5	0	0	0	0	0.00	0.00	0.00	0.00
70	77	19	884	1079	7791	17661	12.88	15.72	113.50	257.28
71	86	5	0	0	0	0	0.00	0.00	0.00	0.00
72	85	5	0	0	0	0	0.00	0.00	0.00	0.00
73	36	26	1224	1494	10785	24449	8.34	10.18	73.50	166.61

Table G-9 Future Conditions – Airport-Related Traffic, On-Airport Link Attributes, Traffic Assignment and Vehicle Miles Traveled (VMT) Summary (Continued)

Link Name	Link Distance (ft)	Link Speed (mph)	VOLUME				VMT			
			AM Peak	PM Peak	High 8-Hour	AWDT	AM Peak	PM Peak	High 8-Hour	AWDT
74	255	5	775	946	6826	15473	37.50	45.77	330.25	748.61
75	107	31	86	105	754	1710	1.75	2.13	15.32	34.75
76	95	5	15	19	136	308	0.27	0.34	2.45	5.54
77	180	26	450	550	3967	8993	15.36	18.78	135.42	307.00
78	127	22	255	311	2248	5095	6.16	7.51	54.28	123.02
79	114	26	704	860	6207	14071	15.17	18.53	133.75	303.21
80	395	5	0	0	0	0	0.00	0.00	0.00	0.00
81	419	26	704	860	6207	14071	55.93	68.33	493.14	1117.92
82	814	17	315	385	2775	6292	48.57	59.36	427.86	970.12
83	238	7	297	363	2617	5933	13.41	16.39	118.18	267.93
84	748	31	247	301	2172	4924	34.97	42.61	307.50	697.12
85	876	32	238	291	2097	4753	39.50	48.30	348.06	788.91
86	178	5	508	620	4472	10139	17.08	20.85	150.40	340.99
87	No longer in service									
88	No longer in service									
89	No longer in service									
90	582	12	894	1091	7874	17849	98.56	120.28	868.09	1967.82
103	85	32	14	17	121	274	0.22	0.27	1.94	4.40
104	85	5	0	0	0	0	0.00	0.00	0.00	0.00
105	95	5	0	0	0	0	0.00	0.00	0.00	0.00
106	95	5	0	0	0	0	0.00	0.00	0.00	0.00
107	260	21	137	167	1207	2736	6.75	8.23	59.49	134.86
108	389	21	56	69	498	1128	4.12	5.08	36.68	83.08
109	114	29	59	72	520	1180	1.27	1.56	11.23	25.49
110	169	29	58	71	513	1163	1.85	2.27	16.39	37.16
111	261	5	0	0	0	0	0.00	0.00	0.00	0.00
112	237	32	59	72	520	1180	2.65	3.24	23.37	53.04
113	565	15	31	38	272	615	3.32	4.07	29.13	65.86
114	609	32	21	26	189	427	2.42	3.00	21.79	49.24
115	451	29	274	334	2413	5471	23.40	28.53	206.11	467.31
116	399	22	34	42	302	684	2.57	3.17	22.82	51.68
117	283	22	44	53	385	872	2.36	2.84	20.65	46.76
118	295	29	283	346	2496	5659	15.80	19.32	139.38	316.01
119	240	12	209	255	1840	4172	9.50	11.59	83.65	189.68
120	365	30	55	67	483	1094	3.80	4.63	33.40	75.66
121	356	17	87	107	769	1744	5.87	7.22	51.87	117.64
122	486	16	53	65	468	1060	4.88	5.98	43.07	97.54
123	486	18	107	131	943	2137	9.84	12.05	86.72	196.53

Table G-9 Future Conditions – Airport-Related Traffic, On-Airport Link Attributes, Traffic Assignment and Vehicle Miles Traveled (VMT) Summary (Continued)

Link Name	Link Distance (ft)	Link Speed (mph)	VOLUME				VMT			
			AM Peak	PM Peak	High 8-Hour	AWDT	AM Peak	PM Peak	High 8-Hour	AWDT
124	280	25	40	49	354	804	2.12	2.60	18.76	42.61
125	280	19	59	72	520	1180	3.13	3.82	27.56	62.53
126	631	21	145	177	1275	2889	17.33	21.16	152.40	345.31
127	652	21	56	68	490	1111	6.92	8.40	60.52	137.22
128	257	32	48	59	422	957	2.34	2.87	20.53	46.55
129	257	20	14	17	121	274	0.68	0.83	5.89	13.33
130	422	5	0	0	0	0	0.00	0.00	0.00	0.00
131	493	32	0	0	0	0	0.00	0.00	0.00	0.00
132	361	27	149	182	1312	2975	10.18	12.44	89.68	203.35
133	236	31	49	60	430	975	2.19	2.68	19.21	43.56
134	1521	29	205	250	1803	4086	59.04	72.00	519.24	1176.71
135	1542	31	46	56	407	923	13.44	16.36	118.89	269.62
136	384	5	0	0	0	0	0.00	0.00	0.00	0.00
137	354	10	8	9	68	154	0.54	0.60	4.56	10.33
138	225	10	8	9	68	154	0.34	0.38	2.89	6.55
139	96	10	8	9	68	154	0.15	0.16	1.24	2.81
140	295	31	46	56	407	923	2.57	3.13	22.73	51.56
142	257	29	98	119	860	1949	4.76	5.78	41.80	94.73
147	230	29	66	80	581	1316	2.88	3.49	25.34	57.39
148	794	29	66	80	581	1316	9.92	12.02	87.33	197.80
149	335	29	66	80	581	1316	4.18	5.07	36.82	83.39
154	152	21	330	402	2904	6582	9.50	11.57	83.60	189.48
155	169	5	129	158	1139	2582	4.12	5.04	36.35	82.40
156	87	23	443	540	3899	8839	7.32	8.92	64.40	146.00
157	572	21	180	219	1584	3590	19.48	23.71	171.46	388.61
158	629	32	149	182	1312	2975	17.74	21.67	156.24	354.28
159	1072	32	111	136	980	2223	22.54	27.62	199.04	451.49
160	470	33	0	0	0	0	0.00	0.00	0.00	0.00
161	105	20	493	602	4344	9848	9.84	12.01	86.68	196.50
162	798	18	427	521	3763	8531	64.54	78.75	568.79	1289.50
163	658	29	66	80	581	1316	8.22	9.96	72.35	163.88
164	442	12	65	79	573	1299	5.44	6.62	47.99	108.80
165	139	33	0	0	0	0	0.00	0.00	0.00	0.00
166	538	33	6	7	53	120	0.61	0.71	5.41	12.24
167	418	33	6	7	53	120	0.48	0.55	4.20	9.51
168	433	11	158	192	1388	3146	12.97	15.76	113.94	258.25
169	293	19	443	541	3907	8856	24.61	30.05	217.02	491.93

Table G-9 Future Conditions – Airport-Related Traffic, On-Airport Link Attributes, Traffic Assignment and Vehicle Miles Traveled (VMT) Summary (Continued)

Link Name	Link Distance (ft)	Link Speed (mph)	VOLUME				VMT			
			AM Peak	PM Peak	High 8-Hour	AWDT	AM Peak	PM Peak	High 8-Hour	AWDT
170	262	11	217	264	1908	4326	10.76	13.10	94.65	214.60
171	326	5	18	22	158	359	1.11	1.36	9.77	22.19
172					No longer in service					
173					No longer in service					
174	284	19	443	541	3907	8856	23.80	29.07	209.94	475.86
175	624	14	453	553	3990	9044	53.51	65.33	471.34	1068.37
176	319	23	991	1210	8734	19798	59.79	73.00	526.94	1194.46
177	286	24	991	1210	8734	19798	53.70	65.56	473.24	1072.73
178	353	21	545	666	4804	10891	36.48	44.58	321.59	729.06
179	348	31	602	735	5302	12019	39.64	48.40	349.11	791.40
180	366	22	794	970	6999	15866	55.04	67.24	485.14	1099.76
181	453	8	64	78	566	1282	5.49	6.69	48.55	109.96
182	119	8	82	100	724	1641	1.84	2.24	16.25	36.84
183	50	8	81	99	716	1624	0.77	0.94	6.78	15.37
184	54	8	64	78	566	1282	0.65	0.79	5.74	13.00
185	62	8	23	28	204	462	0.27	0.33	2.39	5.41
186	39	8	64	78	566	1282	0.48	0.58	4.20	9.52
187	35	5	18	22	158	359	0.12	0.14	1.04	2.35
188	101	5	0	0	0	0	0.00	0.00	0.00	0.00
189	182	5	0	0	0	0	0.00	0.00	0.00	0.00
190	194	5	0	0	0	0	0.00	0.00	0.00	0.00
191	174	5	0	0	0	0	0.00	0.00	0.00	0.00
192	542	5	41	50	362	821	4.21	5.14	37.18	84.32
193	138	5	455	556	4012	9096	11.88	14.51	104.71	237.41
194	932	7	446	544	3929	8908	78.70	95.99	693.30	1571.88
195	79	12	17	21	151	342	0.26	0.32	2.27	5.14
196	49	19	203	248	1787	4052	1.87	2.29	16.47	37.34
197	83	19	443	541	3907	8856	7.01	8.55	61.78	140.04
198	692	5	217	265	1916	4343	28.44	34.73	251.12	569.22
200	245	33	0	0	0	0	0.00	0.00	0.00	0.00
201	160	11	159	194	1403	3180	4.81	5.87	42.43	96.17
202	335	5	0	0	0	0	0.00	0.00	0.00	0.00
204	2022	11	64	78	566	1282	24.51	29.87	216.72	490.88
207	859	33	73	89	641	1453	11.87	14.47	104.25	236.31
208	284	30	420	513	3703	8395	22.59	27.59	199.17	451.53
209	80	22	697	851	6139	13917	10.61	12.95	93.44	211.83
210	71	22	791	966	6969	15798	10.70	13.06	94.23	213.62

Table G-9 Future Conditions – Airport-Related Traffic, On-Airport Link Attributes, Traffic Assignment and Vehicle Miles Traveled (VMT) Summary (Continued)

Link Name	Link Distance (ft)	Link Speed (mph)	VOLUME				VMT			
			AM Peak	PM Peak	High 8-Hour	AWDT	AM Peak	PM Peak	High 8-Hour	AWDT
211	390	22	1116	1363	9835	22294	82.40	100.63	726.14	1646.02
212	117	22	306	373	2692	6104	6.79	8.28	59.77	135.53
213	1315	24	904	1104	7964	18054	225.15	274.96	1983.53	4496.57
214	446	31	674	822	5936	13455	56.91	69.41	501.22	1136.11
215	1110	32	148	181	1305	2958	31.10	38.04	274.24	621.62
216	905	32	252	307	2217	5027	43.21	52.65	380.19	862.06
217	1050	31	131	160	1154	2616	26.05	31.82	229.47	520.18
218	581	24	329	401	2896	6565	36.18	44.10	318.52	722.05
219	1063	32	205	250	1803	4086	41.29	50.35	363.13	822.93
220	415	31	288	352	2542	5762	22.63	27.66	199.75	452.77
221	698	29	84	102	739	1676	11.11	13.49	97.76	221.72
222	1920	28	62	75	543	1231	22.55	27.28	197.50	447.74
223	1564	28	639	780	5626	12754	189.26	231.02	1666.31	3777.49
224	377	28	440	537	3877	8788	31.45	38.38	277.10	628.10
225	551	28	102	124	897	2035	10.64	12.94	93.60	212.34
226	788	23	193	236	1704	3864	28.80	35.22	254.31	576.67
227	1303	23	338	413	2979	6753	83.39	101.89	734.93	1665.98
228	580	31	876	1069	7715	17490	96.28	117.49	847.93	1922.28
229	1653	32	407	497	3590	8138	127.41	155.58	1123.82	2547.54
230	2058	29	468	572	4125	9352	182.42	222.95	1607.84	3645.23
231	870	16	782	955	6893	15627	128.79	157.28	1135.24	2573.68
232	736	21	746	911	6577	14909	103.95	126.94	916.47	2077.49
233	488	27	532	649	4684	10617	49.17	59.99	432.94	981.32
234	449	25	660	806	5815	13182	56.12	68.53	494.41	1120.77
235	310	14	594	725	5234	11865	34.87	42.56	307.25	696.52
236	310	18	66	80	581	1316	3.88	4.70	34.17	77.39
237	105	9	138	168	1214	2753	2.75	3.35	24.19	54.86
238	697	31	36	44	317	718	4.75	5.80	41.82	94.72
239	186	26	79	96	694	1573	2.78	3.37	24.40	55.29
240	145	31	202	247	1780	4035	5.56	6.80	49.00	111.07
241	578	31	281	343	2474	5608	30.79	37.58	271.05	614.41
242	125	32	104	126	913	2069	2.46	2.98	21.58	48.91
243	564	32	104	126	913	2069	11.11	13.46	97.51	220.96
244	88	32	36	44	317	718	0.60	0.73	5.25	11.90
245	48	32	68	83	596	1351	0.61	0.75	5.36	12.16
246	175	17	242	296	2134	4838	8.02	9.81	70.72	160.32
247	65	5	0	0	0	0	0.00	0.00	0.00	0.00

Table G-9 Future Conditions – Airport-Related Traffic, On-Airport Link Attributes, Traffic Assignment and Vehicle Miles Traveled (VMT) Summary (Continued)

Link Name	Link Distance (ft)	Link Speed (mph)	VOLUME				VMT			
			AM Peak	PM Peak	High 8-Hour	AWDT	AM Peak	PM Peak	High 8-Hour	AWDT
248	39	17	345	421	3039	6890	2.53	3.09	22.31	50.59
249	128	17	193	235	1697	3847	4.67	5.69	41.07	93.10
250	484	17	198	241	1742	3949	18.17	22.11	159.84	362.35
251	388	33	49	60	430	975	3.60	4.41	31.62	71.70
252	308	14	299	365	2632	5967	17.47	21.32	153.77	348.60
253	54	15	3	3	23	51	0.03	0.03	0.23	0.52
254	51	5	0	0	0	0	0.00	0.00	0.00	0.00
255	290	31	0	0	0	0	0.00	0.00	0.00	0.00
256	377	31	23	28	204	462	1.64	2.00	14.57	33.01
257	215	31	9	11	83	188	0.37	0.45	3.38	7.66
258	321	31	104	127	920	2086	6.32	7.72	55.91	126.77
259	203	31	86	106	762	1727	3.30	4.07	29.23	66.25
260	362	31	83	101	732	1658	5.68	6.92	50.12	113.53
261	219	30	25	30	219	496	1.04	1.25	9.10	20.60
262	218	11	9	10	75	171	0.37	0.41	3.09	7.05
263	177	33	27	33	241	547	0.90	1.10	8.07	18.31
264	157	5	0	0	0	0	0.00	0.00	0.00	0.00
265	2458	28	80	97	701	1590	37.24	45.15	326.32	740.16
266	752	28	421	514	3711	8412	59.96	73.20	528.51	1198.01
267	1323	28	496	606	4374	9916	124.25	151.80	1095.67	2483.92
268	1252	23	381	465	3356	7608	90.31	110.23	795.52	1803.43
269	302	32	14	17	121	274	0.80	0.97	6.93	15.70
270	1005	22	692	844	6094	13814	131.71	160.64	1159.89	2629.25
271	954	15	1120	1367	9865	22363	202.31	246.92	1781.94	4039.48
272	656	19	884	1079	7791	17661	109.84	134.07	968.08	2194.49
273	485	5	508	620	4472	10139	46.67	56.96	410.86	931.51
274	1244	30	330	403	2911	6599	77.75	94.95	685.85	1554.76
275	419	33	200	245	1765	4001	15.88	19.45	140.11	317.61
276	649	30	323	394	2843	6446	39.69	48.41	349.33	792.05
277	2473	14	86	106	762	1727	40.29	49.66	356.96	809.02
278	573	32	804	981	7082	16054	87.28	106.49	768.80	1742.77
279	458	21	280	342	2466	5591	24.27	29.65	213.79	484.71
280	295	29	177	216	1561	3539	9.90	12.08	87.27	197.85
281	440	25	170	208	1501	3402	14.15	17.32	124.96	283.22
282	76	25	91	111	799	1812	1.32	1.61	11.57	26.23
283	697	25	256	312	2255	5112	33.77	41.16	297.47	674.36
284	690	22	448	547	3944	8942	58.51	71.44	515.08	1167.80

Table G-9 Future Conditions – Airport-Related Traffic, On-Airport Link Attributes, Traffic Assignment and Vehicle Miles Traveled (VMT) Summary (Continued)

Link Name	Link Distance (ft)	Link Speed (mph)	VOLUME				VMT			
			AM Peak	PM Peak	High 8-Hour	AWDT	AM Peak	PM Peak	High 8-Hour	AWDT
285	91	22	283	346	2496	5659	4.88	5.96	43.00	97.48
286	464	22	880	1074	7753	17576	77.35	94.40	681.44	1544.83
287	229	28	949	1159	8364	18961	41.19	50.30	363.03	822.98
288	500	9	700	855	6169	13985	66.22	80.89	583.63	1323.08
289	738	17	2045	2497	18018	40845	285.85	349.03	2518.58	5709.37
290	190	17	1911	2333	16841	38178	68.68	83.84	605.22	1372.01
291	494	18	805	982	7089	16071	75.36	91.93	663.60	1504.41
292	689	25	1107	1351	9752	22106	144.37	176.19	1271.78	2882.89
293	325	27	1228	1500	10823	24534	75.60	92.35	666.33	1510.46
294	396	24	152	185	1335	3026	11.41	13.89	100.21	227.14
295	1017	29	1079	1317	9503	21542	207.86	253.71	1830.66	4149.87
296	162	21	136	166	1199	2718	4.18	5.10	36.82	83.47
297	140	21	136	166	1199	2718	3.60	4.40	31.76	72.00
298	951	12	117	143	1033	2342	21.08	25.76	186.12	421.97
299	805	18	187	229	1652	3744	28.51	34.92	251.90	570.88
300	518	16	116	142	1026	2325	11.39	13.94	100.71	228.21
301	749	12	117	143	1033	2342	16.60	20.29	146.57	332.30
302	652	15	152	186	1342	3043	18.77	22.97	165.71	375.75
303	547	5	83	101	732	1658	8.59	10.46	75.78	171.65
304	406	5	25	30	219	496	1.92	2.31	16.84	38.13
305	442	5	28	34	249	564	2.34	2.85	20.85	47.23
306	207	8	53	65	468	1060	2.08	2.55	18.36	41.57
307	70	5	135	165	1192	2701	1.79	2.19	15.81	35.81
308	319	13	50	61	437	992	3.02	3.69	26.41	59.95
309	281	6	67	82	588	1334	3.56	4.36	31.28	70.97
310	880	29	592	723	5219	11831	98.69	120.53	870.07	1972.38
311	208	28	337	412	2972	6736	13.28	16.23	117.08	265.36
314	203	25	803	980	7074	16037	30.90	37.71	272.19	617.07
317	180	13	516	630	4548	10309	17.59	21.48	155.05	351.46
318	221	15	0	0	0	0	0.00	0.00	0.00	0.00
319	2544	14	64	78	566	1282	30.83	37.58	272.69	617.65
320	552	12	146	179	1290	2924	15.25	18.70	134.79	305.51
321	628	12	169	206	1486	3368	20.11	24.51	176.83	400.79
322	245	10	515	629	4540	10292	23.90	29.19	210.70	477.64
323	260	12	254	310	2240	5078	12.53	15.29	110.51	250.53
325	407	5	265	323	2330	5283	20.44	24.91	179.68	407.41
327	463	14	46	56	407	923	4.03	4.91	35.69	80.94

Table G-9 Future Conditions – Airport-Related Traffic, On-Airport Link Attributes, Traffic Assignment and Vehicle Miles Traveled (VMT) Summary (Continued)

Link Name	Link Distance (ft)	Link Speed (mph)	VOLUME				VMT			
			AM Peak	PM Peak	High 8-Hour	AWDT	AM Peak	PM Peak	High 8-Hour	AWDT
332	993	6	323	394	2843	6446	60.73	74.08	534.57	1212.04
334	366	14	46	56	407	923	3.19	3.88	28.19	63.92
338	407	5	43	52	377	855	3.32	4.01	29.09	65.98
339	442	13	114	139	1003	2274	9.53	11.63	83.89	190.20
347	351	12	120	146	1056	2394	7.97	9.70	70.14	159.02
348	146	18	404	493	3560	8070	11.18	13.65	98.55	223.39
349	67	18	404	493	3560	8070	5.11	6.23	45.00	102.02
350	329	5	57	70	505	1145	3.55	4.36	31.44	71.29
351	359	5	10	13	91	205	0.68	0.88	6.19	13.95
352	395	5	89	109	784	1778	6.67	8.16	58.72	133.16
353	351	5	45	54	392	889	2.99	3.59	26.07	59.12
354	50	8	120	146	1056	2394	1.14	1.38	10.00	22.67
355	88	12	57	70	505	1145	0.95	1.17	8.43	19.12
356	113	24	407	496	3582	8121	8.71	10.62	76.69	173.86
358	463	14	307	375	2708	6138	26.90	32.86	237.30	537.88
359	229	13	3	3	23	51	0.13	0.13	1.00	2.21
360	245	13	2	2	15	34	0.09	0.09	0.70	1.58
361	248	16	41	50	362	821	1.92	2.35	16.99	38.53
362	199	7	36	44	317	718	1.36	1.66	11.96	27.08
363	230	28	244	298	2149	4873	10.62	12.97	93.53	212.08
364	256	8	346	422	3047	6907	16.79	20.47	147.82	335.08
365	201	23	17	21	151	342	0.65	0.80	5.74	13.01
366	201	10	75	92	664	1505	2.86	3.51	25.30	57.35
367	337	32	386	471	3401	7711	24.64	30.07	217.11	492.25
368	868	12	327	399	2881	6531	53.78	65.63	473.85	1074.18
369	266	30	324	395	2851	6463	16.34	19.92	143.76	325.89
370	96	18	223	272	1961	4445	4.04	4.93	35.53	80.53
372	283	29	255	311	2248	5095	13.66	16.66	120.42	272.94
373	283	31	185	226	1629	3693	9.91	12.11	87.27	197.83
400	751	30	323	394	2843	6446	45.93	56.03	404.31	916.70
402	400	14	64	78	566	1282	4.85	5.91	42.91	97.19
403	192	5	0	0	0	0	0.00	0.00	0.00	0.00
404	669	21	337	412	2972	6736	42.72	52.22	376.70	853.79
406	90	26	436	532	3839	8702	7.41	9.04	65.21	147.82
407	484	25	771	942	6795	15404	70.70	86.38	623.08	1412.49
408	180	33	155	189	1365	3095	5.28	6.43	46.47	105.35
409	82	12	43	52	377	855	0.67	0.81	5.87	13.31

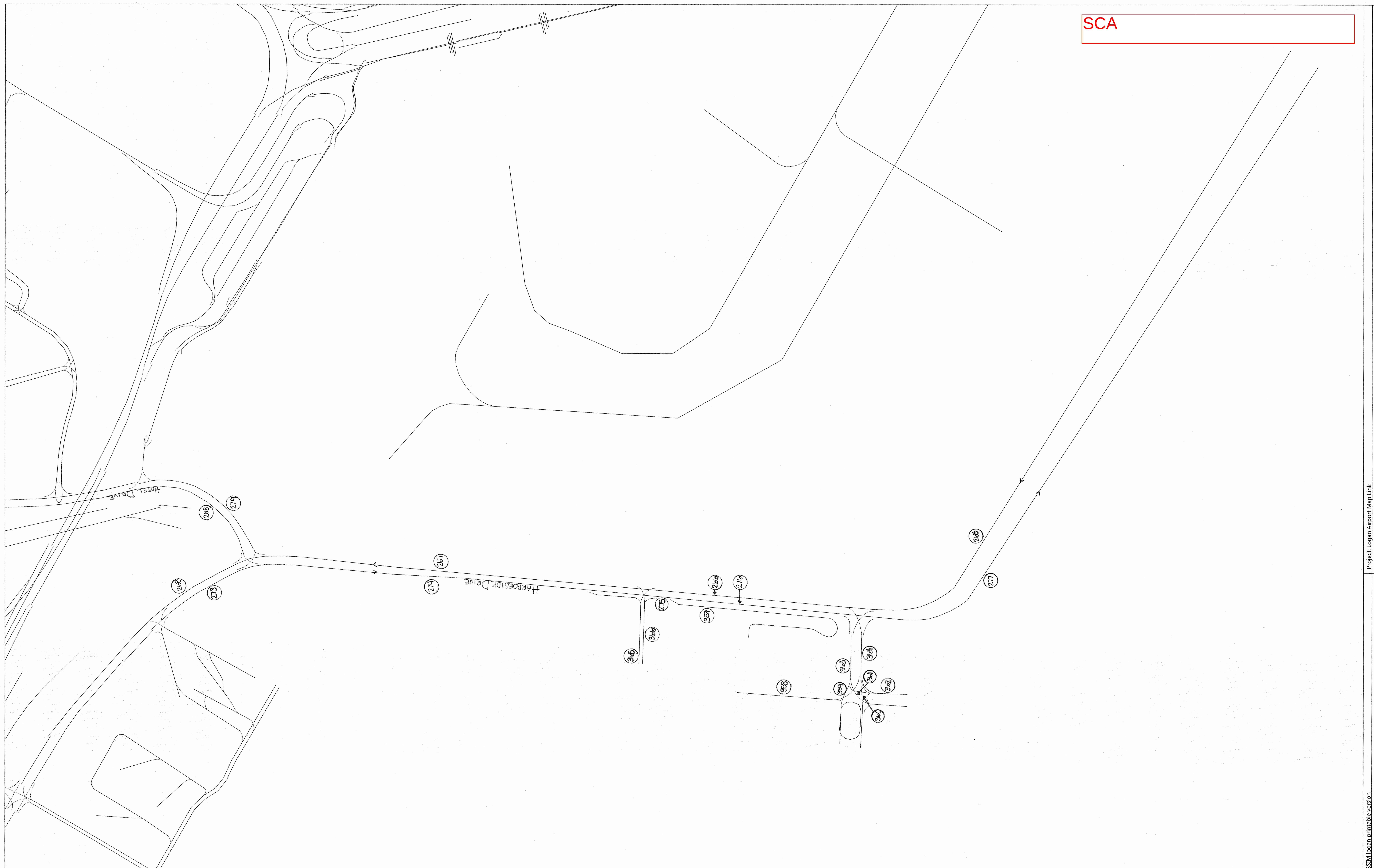
Table G-9 Future Conditions – Airport-Related Traffic, On-Airport Link Attributes, Traffic Assignment and Vehicle Miles Traveled (VMT) Summary (Continued)

Link Name	Link Distance (ft)	Link Speed (mph)	VOLUME				VMT			
			AM Peak	PM Peak	High 8-Hour	AWDT	AM Peak	PM Peak	High 8-Hour	AWDT
410	58	12	130	159	1146	2599	1.42	1.74	12.52	28.38
411	33	12	120	146	1056	2394	0.76	0.92	6.69	15.16
416	466	14	130	159	1146	2599	11.48	14.04	101.17	229.44
418	0	5	0	0	0	0	0.00	0.00	0.00	0.00
420	75	30	329	401	2896	6565	4.70	5.72	41.33	93.70
421	344	29	654	798	5762	13062	42.63	52.02	375.63	851.52
422	312	22	67	82	588	1334	3.95	4.84	34.70	78.72
423	396	5	221	270	1946	4411	16.55	20.23	145.77	330.42
424	440	25	734	896	6463	14652	61.15	74.65	538.46	1220.73
			LOGAN AIRPORT VMT				**8,950**	**10,927**	**78,863**	**178,774**

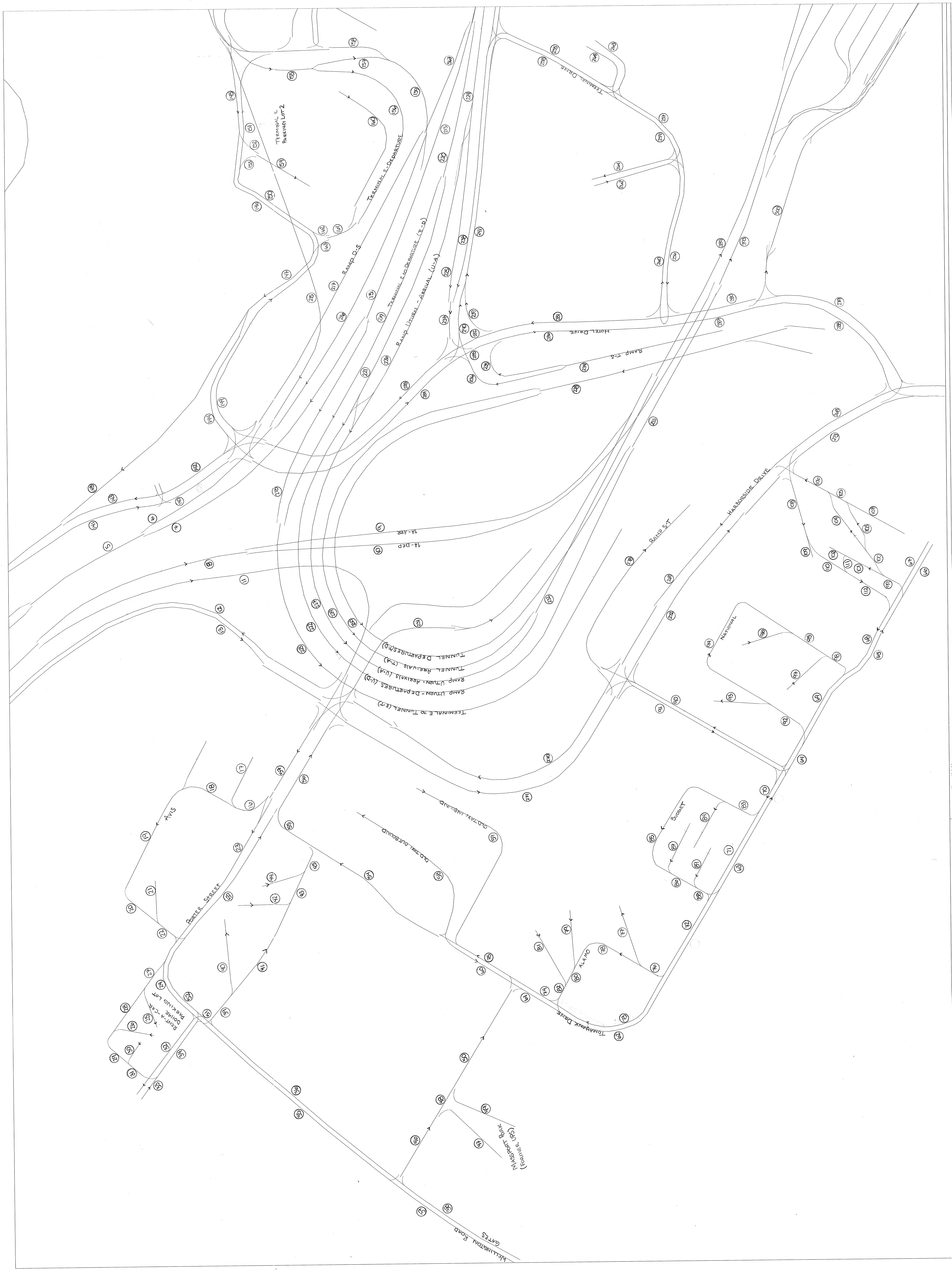
Source: VHB.
Notes: AWDT = Average annual weekday daily traffic.

VISSIM 2011 logan network map	Project: 2011 Logan Network
File: 2011 logan network map.inp	Scenario: Network Map
Simulation Time: 0.0	


NSA/NCA
VISSIM logan printable version
File: logan printable version.inp
Simulation Time: 0.0
Project: Logan Airport Link Map
Scenario: Logan North, Noth Cargo Area
SCT IB
RT 1A-IB
RT 1A-OB
SCT OB
COTTAGE STREET
ECONOMY BUS DRIVEWAY
SERVICE ROAD
RAMP 1H-SB
ECONOMY PARKWAY DRIVE
PRESCOTT STREET
FRANKFORT STREET
LOVELL


SCA
Hotel Drive
Harborside Drive
Project: Logan Airport Map Link
Scenario: Harborside Drive
VISSIM logan printable version
File: logan printable version.inp
Simulation Time: 0.0

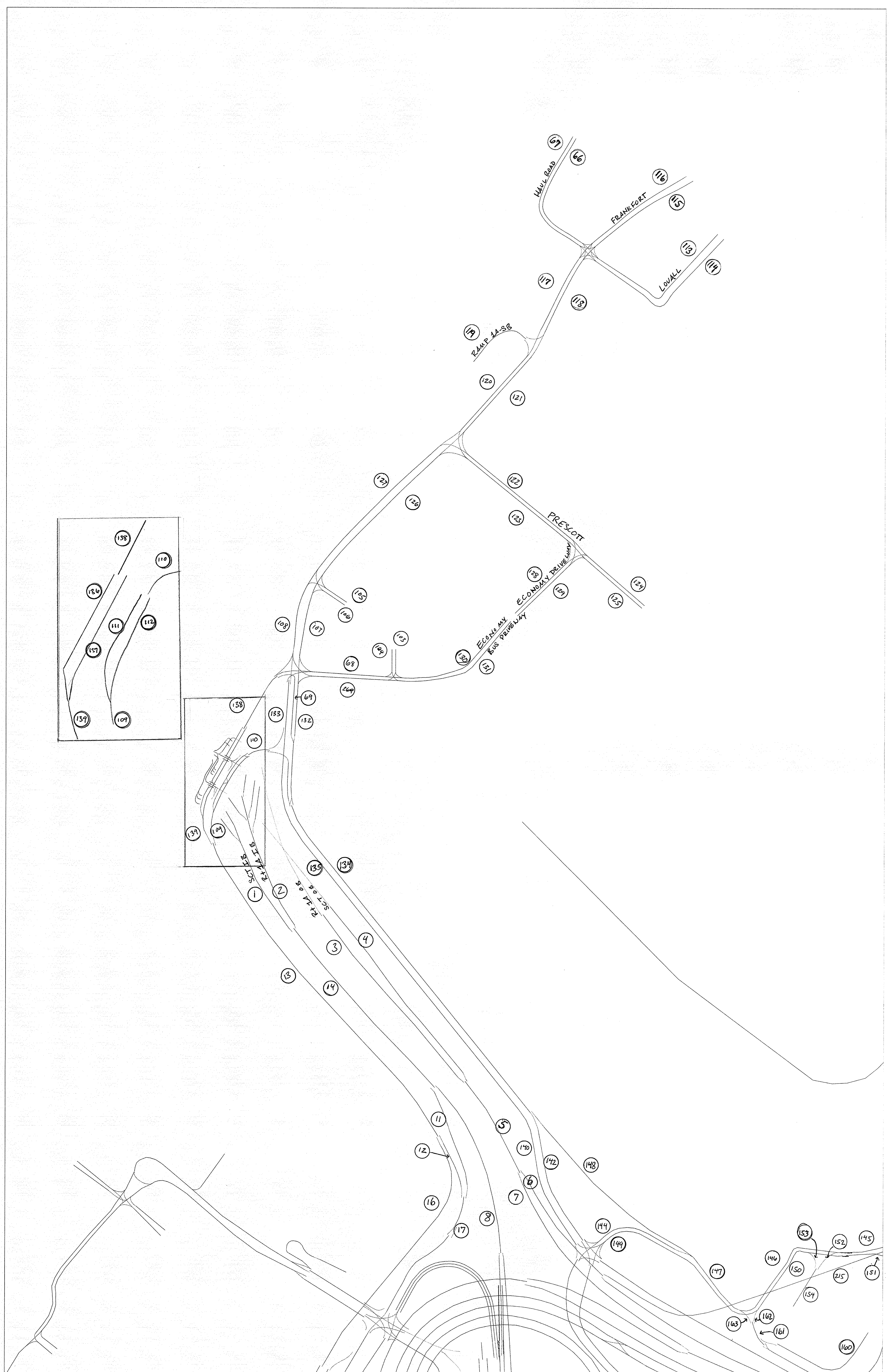
SWSA/Service Roadways




Terminals
Terminal Drive
Project: Logan Airport Link Map
Scenario: Logan Tunnel Ramps, Rental Car Lots
VISSIM logan printable version
File: logan printable version.inp
Simulation Time: 0.0

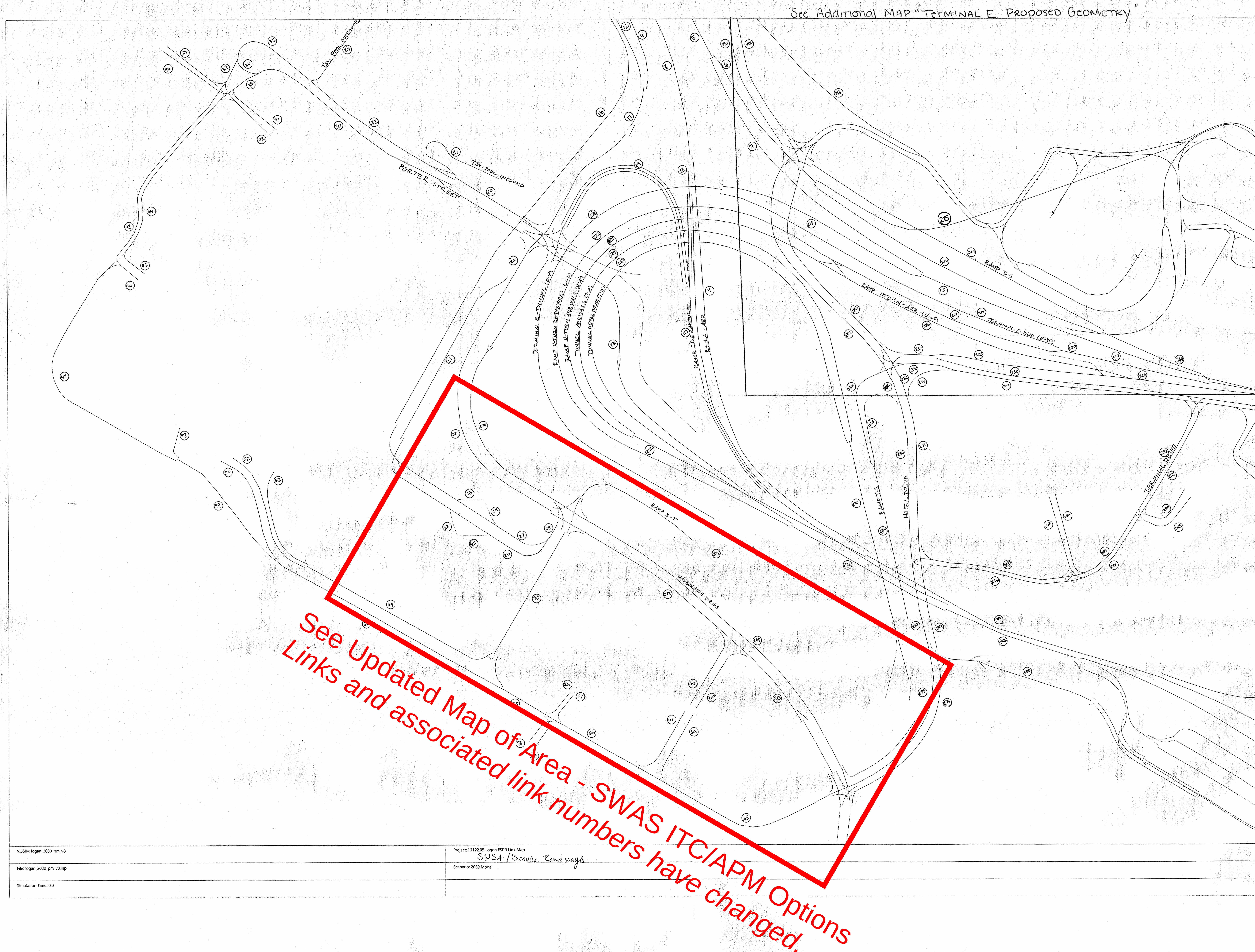
This Page Intentionally Left Blank.

VISSIM 2011 logan network map	Project: 2011 Logan Network
File: 2011 logan network map.inp	Scenario: Network Map
Simulation Time: 0.0	



VISSIM logan_2030_pm_v8	Project: 11122.05 Logan ESPR Link Map NCA / NSA
File: logan_2030_pm_v8.inp	Scenario: 2030 Model
Simulation Time: 0.0	

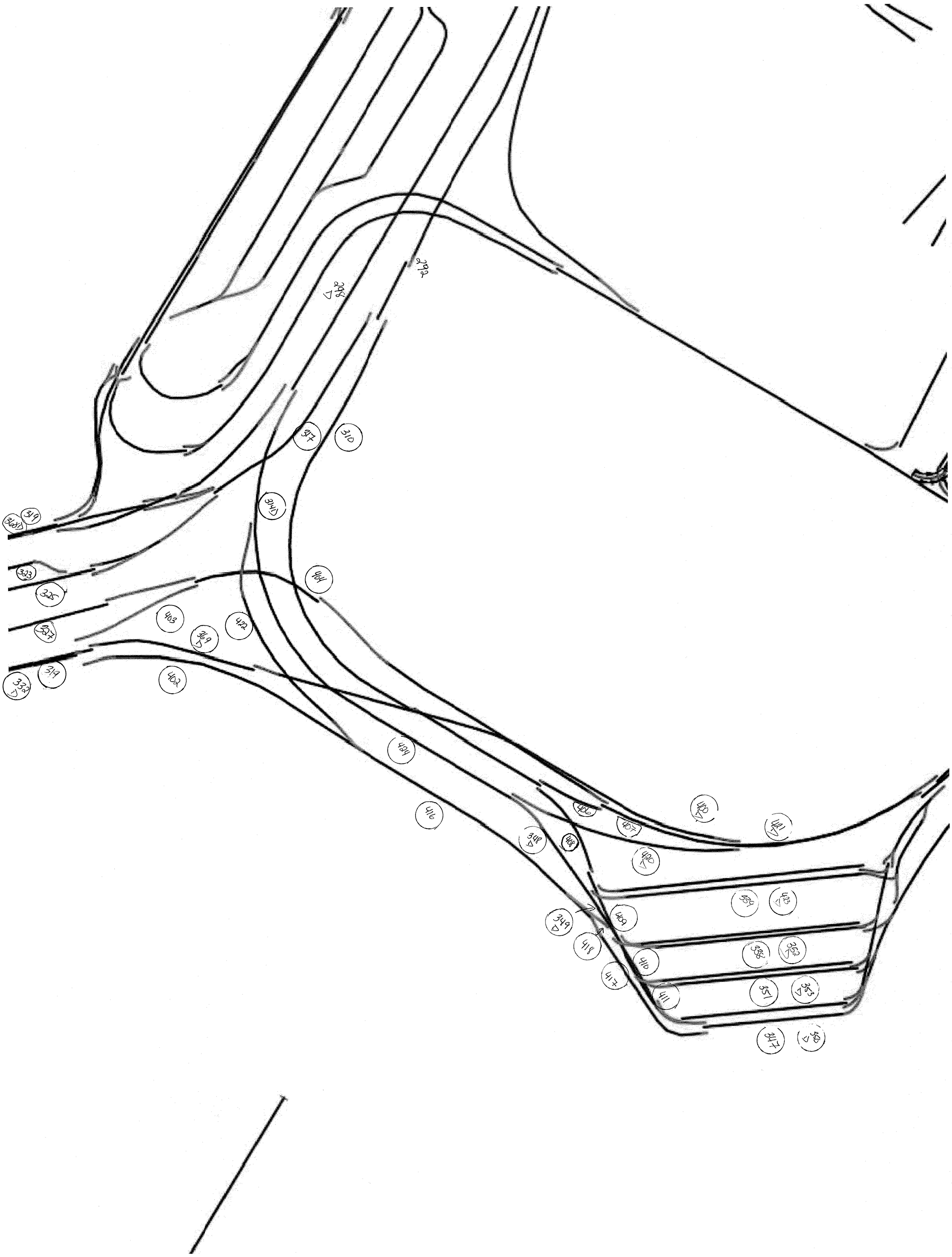
VISSIM logan_2030_pm_v8	Project: 11122.05 Logan ESPR Link Map SCA
File: logan_2030_pm_v8.inp	Scenario: 2030 Model
Simulation Time: 0.0	


See Additional MAP "Terminal E Proposed Geometry"
Taxi Pool Outbound
Taxi Pool Inbound
Porter Street
Terminal E Tunnel (E-T)
Ramp U-Turn Departures (U-D)
Ramp U-Turn Arrivals (U-A)
Tunnel Arrivals (T-A)
Tunnel Departures (T-D)
Ramp - Departures
Ramp - Arr
Ramp D-S
Ramp U-Turn - Arr (U-A)
Terminal E-Dep (E-D)
Ramp S-T
Harborside Drive
Ramp I-S
Hotel Drive
Terminal Drive
See Updated Map of Area - SWAS ITC/APM Options
Links and associated link numbers have changed.
VISSIM logan_2030_pm_v8
File: logan_2030_pm_v8.inp
Simulation Time: 0.0
Project: 11122.05 Logan ESPR Link Map
SWS4 / Service Roadways
Scenario: 2030 Model

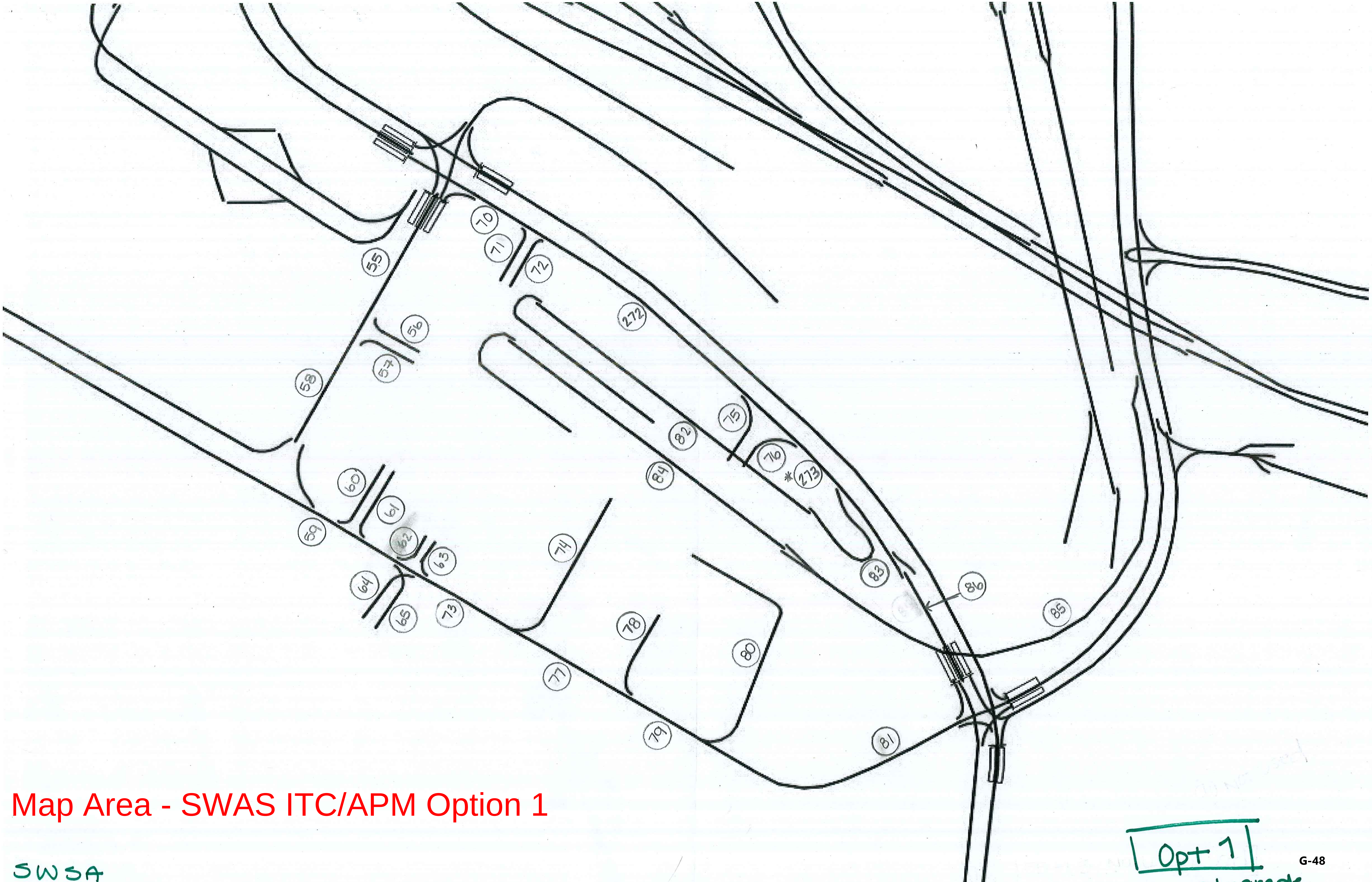

See Additional MAP "Terminal E Proposed Geometry"
Terminal Drive
See Updated Map of Area - TAR B-C Roadway
Links and associated link numbers have changed.
VISSIM logan printable version
File: logan printable version.inp
Simulation Time: 0.0
Project: Logan Airport Link Map - 2030 - Terminals
Scenario: Logan Tunnel Ramps, Rental Car Lots
Terminal E Project No Build w/ Garage

Map Area - Terminal E Proposed Geometry

Map Area - TAR B-C Roadway



SD MAP - Term B/C Connection



Map Area - SWAS ITC/APM Option 1

SWSA

Opt 1
at-grade

Massachusetts Port Authority
One Harborside Drive, Suite 200-S
East Boston, MA 02128-2909
Telephone: 617-568-5000
www.massport.com

March 1 2017

Christine Kirby, Director, Air & Climate Division
Massachusetts Department of Environmental Protection
Bureau of Air & Waste
One Winter Street
Boston, MA 02108

Re: Logan Airport Parking Space Inventory

Dear Ms. Kirby:

In compliance with the reporting requirements of 310 CMR 7.30 (3)(d), enclosed are the following Massachusetts Port Authority (Massport) submissions for Logan Airport:

- Commercial Parking Space Inventory
- Employee Parking Space Inventory
- Location Map

The attachments provide the quantity, physical distribution, and allocation of commercial and employee parking spaces on the airport, as defined by 310 CMR 7.30, as amended. These inventory tables represent information provided by the Aviation Department and are supported by comprehensive field checks and counts conducted in late February 2017.

The Commercial Parking Space Inventory totals 18,640 spaces; the Employee Parking Space Inventory totals 2,448 parking spaces; the total inventory of spaces at Logan Airport is 21,088. For your information, we continue to provide information on rental car spaces.

The attached Logan Airport Parking Space Inventory reflects Massport's successful management of its parking program, within the requirements of 310 CMR 7.30, as amended. If you have any questions, please call me at 617-568-3689.

Sincerely,

Hayes Morrison
Deputy Director - Maritime, Land Use, and
Transportation Planning
Strategic & Business Planning Department

cc:

D. Conroy, EPA
L. Gilmore, MPA
S. Dalzell, MPA
M. Kalowski, MPA

Commercial Parking Space Inventory
Logan International Airport
March 2017 Submission

Commercial Parking Spaces

Old Map ID#	Map ID#	Location of Commercial Parking Areas	Number of Spaces (Mar-17)
	Terminal Area and Economy Spaces		
C1a	C1	Central Garage	7179
C1b	C2	West Garage	3076
		West Garage Expansion	1699
C2	C3	Terminal B Garage	2212
C8a	C5	Terminal E Lot 1	237
C8b	C6	Terminal E Lot 2	249
C9	C7	Terminal E Lot 3 (fka "Gulf Station" Lot)	217
	C12	Blue Lot	367
C6	C8	Economy Garage	2864
		subtotal	18100
	Overflow Commercial Spaces		
	C11	Red Lot (Tomahawk Dr.)	
	C13	Green Lot (Wood Island)	
		subtotal	0
	Hotel Spaces		
C4	C4a ~~& C4b~~	Logan Airport Hilton Hotel (one lot)	235
C7a	C10	Harborside Hyatt Conference Center	270
		subtotal	505
	General Aviation Spaces		
C5	C9	Signature (General Aviation Terminal)	35
		subtotal	35

Total In-Service Commercial Parking Spaces	**18,640**
Total Designated Commercial Parking Spaces	**0**
Total Commercial Parking Spaces	**18,640**
Total Employee Parking Spaces *(see table on next page)*	**2,448**
TOTAL PARKING FREEZE SPACES	**21,088**

Employee Parking Space Inventory
Logan International Airport
March 2017 Submission

As of 2014: space count excludes

Employee Parking Spaces

Area		Map ID#	Location of Employee Parking Areas	Number of Spaces Mar-17
Terminal	Terminal Area	E81	West Garage	98
Terminal	Terminal Area	E26	Airport Tower/Administration (parking in Central Garage)	521
Terminal	Terminal Area	E20	Terminal C Pier A (Old Terminal D) (two lots)	122
Terminal	Terminal Area	E18	Massport Facilities 1 (Heating Plant)	92
Terminal	Terminal Area	E34	Hilton Hotel employee lot	28
Terminal	Terminal Area	E86	Gulf Gas Station	4
North	North Service Area	E68a	LSG Sky Chefs (Bldg. 68), main lot	25
North	North Service Area	E68b	LSG Sky Chefs (Bldg. 68), overflow lot	126
North	North Service Area	E1	Flight Kitchen Building 1 (and nearby lot)	80
North	North Service Area	E40	Lovell Street Lot (contractor trailer)	25
North	North Service Area	E53	Green Bus Depot (Bus Maintenance Facility)	12
North	North Service Area	E11a	North Cargo Building 11, TSA lot	93
North	North Service Area	E11b	North Cargo Building 11, State Police lot	136
North	North Service Area	E43	North Gate & EMS Trailer (EMS Station A7)	21
North	North Service Area	E8	North Cargo Building 8	114
North	North Service Area	E5	US Airways Administration/Hangar (Bldg. 5)	75
airside	North Service Area	*N/A*	Massport Facilities 2 (airside, Bldg. 3)	0
North	North Service Area	E4	Massport Facilities 3 (landside, Bldg. 4)	69
North	North Service Area	E13	UPS (Cargo Building 13)	44
North	North Service Area	E94	United Aircraft Maintenance (Buildings 93 & 94)	56
SW	SWSA	E59	Bus/Limo Pool Lot	4
SW	SWSA	E60	Rental Car Center (Customer Service Center)	4
SW	SWSA	E72	Taxi Pool Lot	8
South	South Service Area	E84	Bird Island Flats / Logan Office Center (LOC) Garage	416
South	South Service Area	E63	South Cargo Building 63	16
South	South Service Area	E62	South Cargo Building 62	43
South	South Service Area	E58	South Cargo Building 58	23
South	South Service Area	E57	South Cargo Building 57	44
South	South Service Area	E56	South Cargo Building 56	39
South	South Service Area	E78	Fire-Rescue HQ & Amelia Earhart Terminal/Hangar	84
airside		*N/A*	*ARFF Satellite Station* [1]	0

[1] This facility is located on the airfield and is not shown in the map. No employee parking spaces are provided.

Total In-Service Employee Parking Spaces	**2,422**
Total Designated Employee Parking Spaces	**26**
Total Employee Parking Spaces	**2,448**
Total Commercial Parking Spaces *(see table on previous page)*	**18,640**
TOTAL PARKING SPACES	**21,088**
TOTAL PARKING FREEZE SPACES	21,088

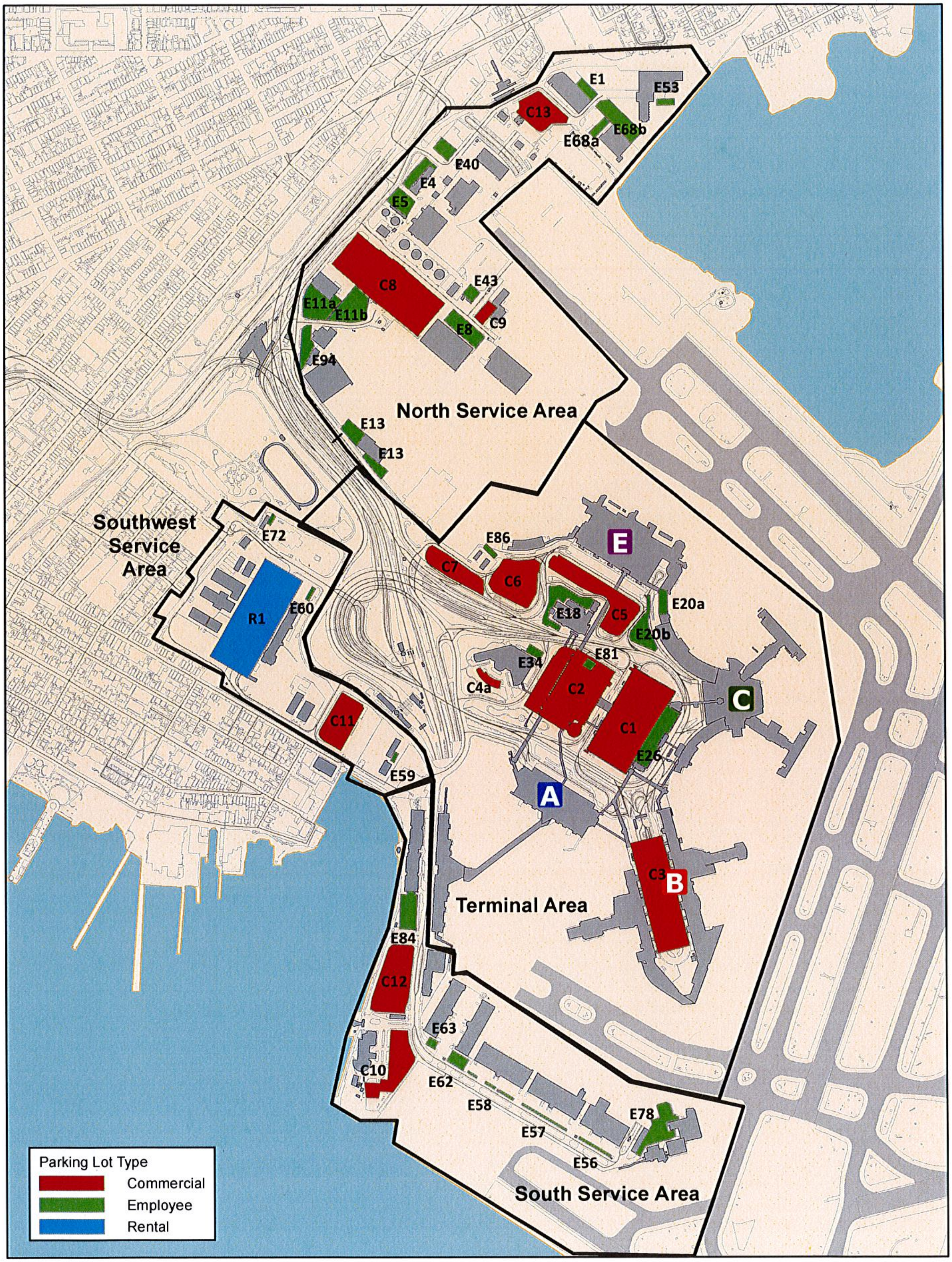
SUMMARY

TOTAL COMMERCIAL PARKING SPACES	***18,640***
TOTAL EMPLOYEE PARKING SPACES	***2,448***
TOTAL PARKING FREEZE SPACES	***21,088***

For Information Only:
Rental Car Spaces Inventory
Logan International Airport
March 2017 Submission

Rental Car Company Parking Spaces

Map ID#		Number of Spaces
R1	Rental Car Center (RCC)	5,020
Total Rental Car Spaces		**5,020**



Massachusetts Port Authority
Strategic and Business Planning
September 2016

N

0 0.075 0.15 0.3 Miles

Logan Airport Parking Space Inventory

Projection: Lambert Conformal Conic **Coordinate System:** NAD 1983 State Plane Massachusetts Mainland FIPS 2001 (Meter)

Massachusetts Port Authority
One Harborside Drive, Suite 200-S
East Boston, MA 02128-2909
Telephone: 617-568-5000
www.massport.com

September 25, 2017

Christine Kirby, Director, Air & Climate Division
Massachusetts Department of Environmental Protection
Bureau of Air & Waste
One Winter Street
Boston, MA 02108

Re: Logan Airport Parking Space Inventory

Dear Ms. Kirby:

In compliance with the reporting requirements of 310 CMR 7.30 (3)(d), enclosed are the following Massachusetts Port Authority (Massport) submissions for Logan Airport:

- Commercial Parking Space Inventory
- Employee Parking Space Inventory
- Location Map

The attachments provide the quantity, physical distribution, and allocation of commercial and employee parking spaces on the airport, as defined by 310 CMR 7.30, as amended. These inventory tables represent information provided by the Aviation Department and are supported by comprehensive field checks and counts conducted in September, 2017.

The Commercial Parking Space Inventory totals 18,640 spaces; the Employee Parking Space Inventory totals 2,448 parking spaces; the total inventory of spaces at Logan Airport is 21,088. For your information, we continue to provide information on rental car spaces.

The attached Logan Airport Parking Space Inventory reflects Massport's successful management of its parking program, within the requirements of 310 CMR 7.30, as amended. If you have any questions, please call me at 617-568-3689.

Sincerely,

Hayes Morrison
Deputy Director - Maritime, Land Use, and Transportation Planning
Strategic & Business Planning Department

cc:

D. Conroy, EPA
L. Gilmore, MPA
S. Dalzell, MPA
M. Kalowski, MPA

Commercial Parking Space Inventory
Logan International Airport
September 2017 Submission

Commercial Parking Spaces

Old Map ID#	Map ID#	Location of Commercial Parking Areas	Sep-17 Number of Spaces
	Terminal Area and Economy Spaces		
C1a	C1	Central Garage	7179
C1b	C2	West Garage	3076
		West Garage Expansion	1699
C2	C3	Terminal B Garage	2212
C8a	C5	Terminal E Lot 1	237
C8b	C6	Terminal E Lot 2	249
C9	C7	Terminal E Lot 3 (fka "Gulf Station" Lot)	217
	C12	Blue Lot	367
C6	C8	Economy Garage	2864
		subtotal	18100
	Overflow Commercial Spaces		
	C11	Red Lot (Tomahawk Dr.)	
	C13	Green Lot (Wood Island)	
		subtotal	0
	Hotel Spaces		
C4	C4a ~~& C4b~~	Logan Airport Hilton Hotel (one lot)	235
C7a	C10	Harborside Hyatt Conference Center	270
		subtotal	505
	General Aviation Spaces		
C5	C9	Signature (General Aviation Terminal)	35
		subtotal	35

Total In-Service Commercial Parking Spaces	**18,640**
Total Designated Commercial Parking Spaces	**0**
Total Commercial Parking Spaces	**18,640**
Total Employee Parking Spaces *(see table on next page)*	**2,448**
TOTAL PARKING FREEZE SPACES	**21,088**

Employee Parking Space Inventory
Logan International Airport
September 2017 Submission

Employee Parking Spaces

Area		Map ID#	Location of Employee Parking Areas	Sep-17 Number of Spaces
Terminal	Terminal Area	E81	West Garage	98
Terminal	Terminal Area	E26	Airport Tower/Administration (parking in Central Garage)	521
Terminal	Terminal Area	E20	Terminal C Pier A (Old Terminal D) (two lots)	122
Terminal	Terminal Area	E18	Massport Facilities 1 (Heating Plant)	92
Terminal	Terminal Area	E34	Hilton Hotel employee lot	28
Terminal	Terminal Area	E86	Gulf Gas Station	4
North	North Service Area	E68a	LSG Sky Chefs (Bldg. 68), main lot	25
North	North Service Area	E68b	LSG Sky Chefs (Bldg. 68), overflow lot	126
North	North Service Area	E1	Flight Kitchen Building 1 (and nearby lot)	80
North	North Service Area	E40	Lovell Street Lot (contractor trailer)	25
North	North Service Area	E53	Green Bus Depot (Bus Maintenance Facility)	12
North	North Service Area	E11a	North Cargo Building 11, TSA lot	93
North	North Service Area	E11b	North Cargo Building 11, State Police lot	136
North	North Service Area	E43	North Gate & EMS Trailer (EMS Station A7)	21
North	North Service Area	E8	North Cargo Building 8	114
North	North Service Area	E5	US Airways Administration/Hangar (Bldg. 5)	75
airside	North Service Area	*N/A*	Massport Facilities 2 (airside, Bldg. 3)	0
North	North Service Area	E4	Massport Facilities 3 (landside, Bldg. 4)	69
North	North Service Area	E13	UPS (Cargo Building 13)	44
North	North Service Area	E94	United Aircraft Maintenance (Buildings 93 & 94)	56
SW	SWSA	E59	Bus/Limo Pool Lot	4
SW	SWSA	E60	Rental Car Center (Customer Service Center)	4
SW	SWSA	E72	Taxi Pool Lot	8
South	South Service Area	E84	Bird Island Flats / Logan Office Center (LOC) Garage	416
South	South Service Area	E63	South Cargo Building 63	16
South	South Service Area	E62	South Cargo Building 62	43
South	South Service Area	E58	South Cargo Building 58	23
South	South Service Area	E57	South Cargo Building 57	44
South	South Service Area	E56	South Cargo Building 56	39
South	South Service Area	E78	Fire-Rescue HQ & Amelia Earhart Terminal/Hangar	84
airside		*N/A*	*ARFF Satellite Station* [1]	0

[1] This facility is located on the airfield and is not shown in the map. No employee parking spaces are provided.

Total In-Service Employee Parking Spaces	**2,422**
Total Designated Employee Parking Spaces	**26**
Total Employee Parking Spaces	**2,448**
Total Commercial Parking Spaces *(see table on previous page)*	**18,640**
TOTAL PARKING SPACES	**21,088**
TOTAL PARKING FREEZE SPACES	**21,088**

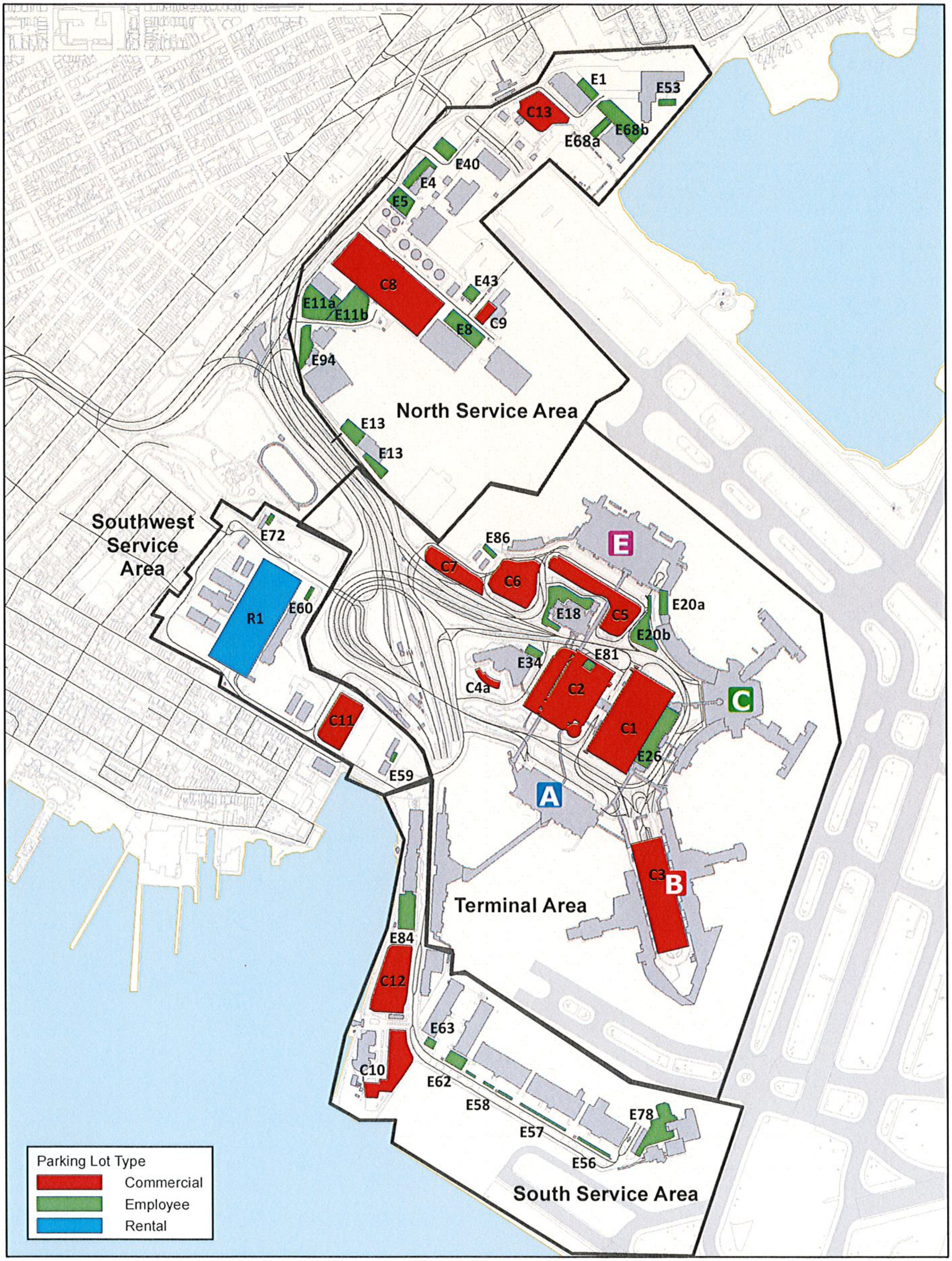
SUMMARY

TOTAL COMMERCIAL PARKING SPACES	*18,640*
TOTAL EMPLOYEE PARKING SPACES	*2,448*
TOTAL PARKING FREEZE SPACES	*21,088*

For Information Only:
Rental Car Spaces Inventory
Logan International Airport
September 2017 Submission

Rental Car Company Parking Spaces

Map ID#		Number of Spaces
R1	Rental Car Center (RCC)	5,020
Total Rental Car Spaces		**5,020**



Massachusetts Port Authority
Strategic and Business Planning
September 2016

Logan Airport Parking Space Inventory

N

0 0.075 0.15 0.3 Miles

Projection: Lambert Conformal Conic **Coordinate System:** NAD 1983 State Plane Massachusetts Mainland FIPS 2001 (Meter)

Massachusetts Port Authority
One Harborside Drive, Suite 200-S
East Boston, MA 02128-2909
Telephone: 617-568-5000
www.massport.com

October 13, 2017

Christine Kirby, Director, Air & Climate Division
Massachusetts Department of Environmental Protection
Bureau of Air & Waste
One Winter Street
Boston, MA 02108

Re: Revised Logan Airport Parking Space Inventory

Dear Ms. Kirby:

This letter hereby amends and replaces the Logan Airport Parking Space Inventory report dated September 25, 2017. In compliance with the reporting requirements of 310 CMR 7.30(3)(a), enclosed please find the following Massachusetts Port Authority (Massport) submissions for Logan Airport (the Airport):

- Commercial Parking Space Inventory;
- Employee Parking Space Inventory; and
- Location Map.

The attachments provide the quantity, physical distribution, and allocation of commercial and employee parking spaces on the Airport, as defined by 310 CMR 7.30, as amended, effective as of June 30, 2017. These inventory tables represent information provided by the Aviation Department and are supported by comprehensive field checks and counts conducted in September, 2017.

The Revised Logan Airport Parking Space Inventory reflects the 310 CMR 7.30, as amended, and effective on June 30, 2017. Accordingly, the Commercial Parking Space Inventory totals 23,640 parking spaces; the Employee Parking Space Inventory totals 2,448 parking spaces; and the total inventory of parking spaces at the Airport is 26,088. Additionally, for your information, we continue to provide information on rental car parking spaces, also attached.

The attached Logan Airport Parking Space Inventory reflects Massport's successful management of its parking program, within the requirements of 310 CMR 7.30, as amended.

If you have any questions, please call me at 617-568-3689.

Sincerely,

Hayes Morrison
Deputy Director - Maritime, Land Use, and
Transportation Planning
Strategic & Business Planning Department

cc: D. Conroy, EPA
L. Gilmore, MPA
S. Dalzell, MPA
M. Kalowski, MPA

Commercial Parking Spaces

Old Map ID#	Map ID#	Location of Commercial Parking Areas	Number of Spaces (Oct-17)
	Terminal Area and Economy Spaces		
C1a	C1	Central Garage	7179
C1b	C2	West Garage	3076
		West Garage Expansion	1699
C2	C3	Terminal B Garage	2212
C8a	C5	Terminal E Lot 1	237
C8b	C6	Terminal E Lot 2	249
C9	C7	Terminal E Lot 3 (fka "Gulf Station" Lot)	217
	C12	Blue Lot	367
C6	C8	Economy Garage	2864
		subtotal	18100
	Overflow Commercial Spaces		
	C11	Red Lot (Tomahawk Dr.)	
	C13	Green Lot (Wood Island)	
		subtotal	0
	Hotel Spaces		
C4	C4a ~~& C4b~~	Logan Airport Hilton Hotel (one lot)	235
C7a	C10	Harborside Hyatt Conference Center	270
		subtotal	505
	General Aviation Spaces		
C5	C9	Signature (General Aviation Terminal)	35
		subtotal	35

Total In-Service Commercial Parking Spaces	**18,640**
Total Designated Commercial Parking Spaces	**23,640**
Total Commercial Parking Spaces	**23,640**
Total Employee Parking Spaces *(see table on next page)*	**2,448**
TOTAL PARKING FREEZE SPACES	**26,088**

Employee Parking Spaces

Oct-17

Area		Map ID#	Location of Employee Parking Areas	Number of Spaces
Terminal	Terminal Area	E81	West Garage	98
Terminal		E26	Airport Tower/Administration (parking in Central Garage)	521
Terminal		E20	Terminal C Pier A (Old Terminal D) (two lots)	122
Terminal		E18	Massport Facilities 1 (Heating Plant)	92
Terminal		E34	Hilton Hotel employee lot	28
Terminal		E86	Gulf Gas Station	4
North	North Service Area	E68a	LSG Sky Chefs (Bldg. 68), main lot	25
North		E68b	LSG Sky Chefs (Bldg. 68), overflow lot	126
North		E1	Flight Kitchen Building 1 (and nearby lot)	80
North		E40	Lovell Street Lot (contractor trailer)	25
North		E53	Green Bus Depot (Bus Maintenance Facility)	12
North		E11a	North Cargo Building 11, TSA lot	93
North		E11b	North Cargo Building 11, State Police lot	136
North		E43	North Gate & EMS Trailer (EMS Station A7)	21
North		E8	North Cargo Building 8	114
North		E5	US Airways Administration/Hangar (Bldg. 5)	75
airside		*N/A*	Massport Facilities 2 (airside, Bldg. 3)	0
North		E4	Massport Facilities 3 (landside, Bldg. 4)	69
North		E13	UPS (Cargo Building 13)	44
North		E94	United Aircraft Maintenance (Buildings 93 & 94)	56
SW	SWSA	E59	Bus/Limo Pool Lot	4
SW		E60	Rental Car Center (Customer Service Center)	4
SW		E72	Taxi Pool Lot	8
South	South Service Area	E84	Bird Island Flats / Logan Office Center (LOC) Garage	416
South		E63	South Cargo Building 63	16
South		E62	South Cargo Building 62	43
South		E58	South Cargo Building 58	23
South		E57	South Cargo Building 57	44
South		E56	South Cargo Building 56	39
South		E78	Fire-Rescue HQ & Amelia Earhart Terminal/Hangar	84
airside		*N/A*	*ARFF Satellite Station* [1]	0

[1] This facility is located on the airfield and is not shown in the map. No employee parking spaces are provided

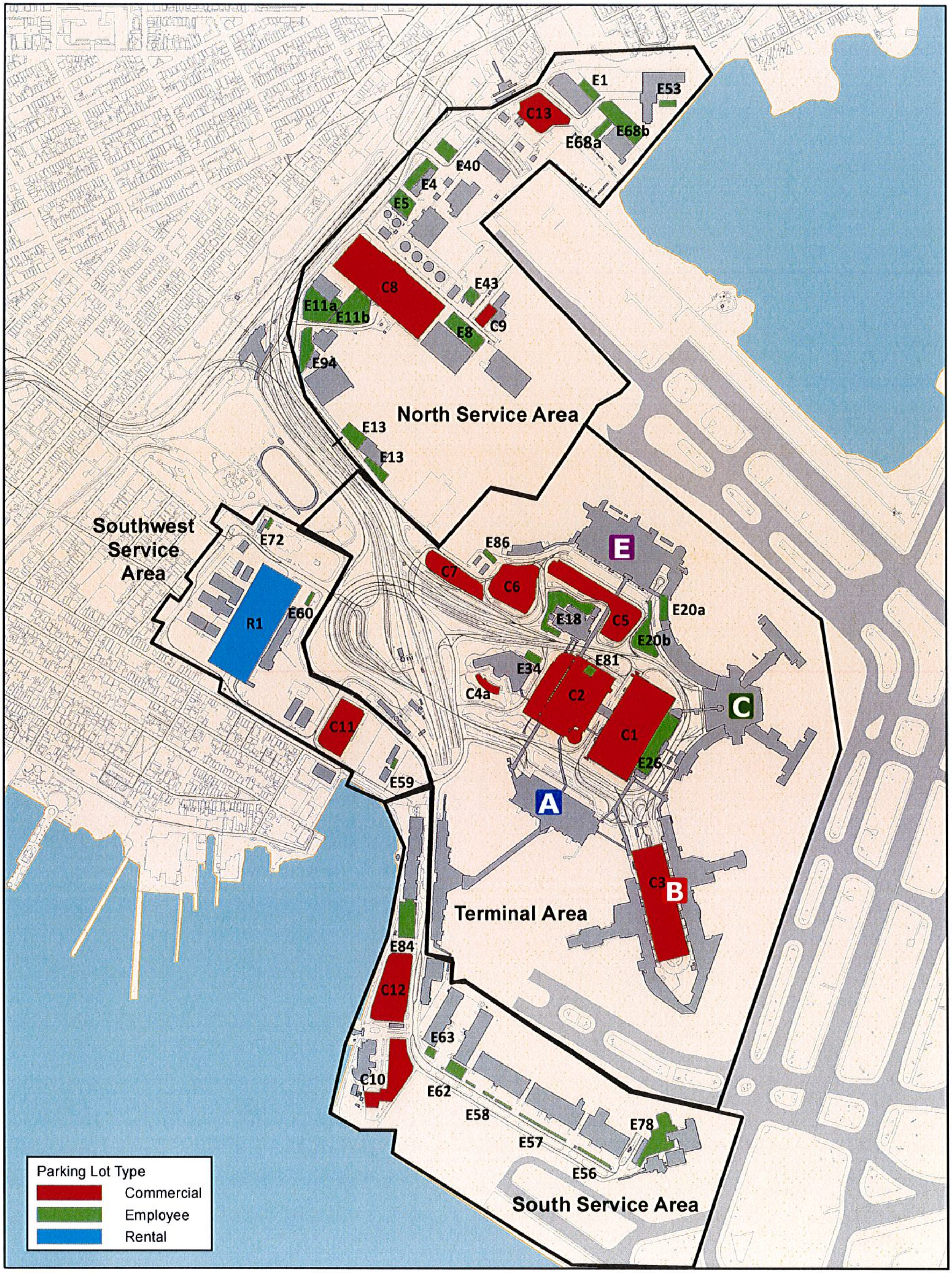
Total In-Service Employee Parking Spaces	**2,422**
Total Designated Employee Parking Spaces	**26**
Total Employee Parking Spaces	**2,448**
Total Commercial Parking Spaces *(see table on previous page)*	**23,640**
TOTAL PARKING SPACES	**26,088**
TOTAL PARKING FREEZE SPACES	**26,088**

SUMMARY

TOTAL COMMERCIAL PARKING SPACES	***18,640***
TOTAL EMPLOYEE PARKING SPACES	***2,448***
TOTAL PARKING FREEZE SPACES	***26,088***

Rental Car Company Parking Spaces

Map ID#		Number of Spaces
R1	Rental Car Center (RCC)	5,020
Total Rental Car Spaces		**5,020**



Massachusetts Port Authority
Strategic and Business Planning
September 2016

Logan Airport Parking Space Inventory

Projection: Lambert Conformal Conic **Coordinate System:** NAD 1983 State Plane Massachusetts Mainland FIPS 2001 (Meter)

H

Noise Abatement

This appendix provides detailed information, tables, and figures in support of Chapter 6, *Noise Abatement*. The contents of this appendix are summarized below.

Appendix Contents

- 2017 DNL Levels for Census Block Group Locations
    - Table H-26 2017 DNL Levels for Census Block Group Locations within DNL 50 dB
- Massport and FAA Correspondence Letters
    - Massport and FAA correspondence letter regarding RNAV Pilot Test: Request that FAA adopt the jetBlue Airways RNAV Visual Approach Procedure to Runway 33L dated April 7, 2017
    - Massport and FAA correspondence letter regarding Massport recommended procedural changes to RNAV dated December 20, 2017
    - FAA June 2018 update letter regarding RNAV Pilot Test: Request that FAA adopt the jetBlue Airways RNAV Visual Approach Procedure to Runway 33L dated June 8, 2018

Fundamentals of Acoustics and Environmental Noise

This section introduces the fundamentals of acoustics and noise terminology as well as the effects of noise on human activity and community annoyance.

Introduction to Acoustics and Noise Terminology

Chapter 6, *Noise Abatement* of this *2017 Environmental Status and Planning Report (ESPR)* relies largely on a measure of cumulative noise exposure over an entire calendar year, in terms of a metric called the Day-Night Average Sound Level (DNL). However, DNL does not always provide a sufficient description of noise for many purposes. Other measures are available to address essentially any issue of concern. This section introduces the following acoustic metrics, which are all related to DNL, but provide bases for evaluating a broad range of noise situations. These metrics include:

- Decibel (dB)
- A-Weighted Decibel (dBA)
- Sound Exposure Level (SEL)
- Equivalent Sound Level (Leq)
- Time Above (TA)
- Time Above, Night (TAN)
- DNL

The Decibel (dB)

All sounds come from a sound source – a musical instrument, a voice speaking, or an airplane that passes overhead. It takes energy to produce sound. The sound energy produced by any sound source is transmitted through the air in the form of sound waves – tiny, quick oscillations of pressure just above and just below atmospheric pressure. These oscillations, or sound pressures, impinge on the ear, creating the sound we hear.

Our ears are sensitive to a wide range of sound pressures. The loudest sounds that we hear without pain have about one million times more energy than the quietest sounds we hear. However, our ears are incapable of detecting small differences in these pressures. Thus, to match how we hear this sound energy, we compress the total range of sound pressures to a more meaningful range by introducing the concept of sound pressure level (SPL). SPL is a measure of the sound pressure of a given noise source relative to a standard reference value (typically the quietest sound that a young person with good hearing can detect). SPLs are measured in decibels (abbreviated dB). Decibels are logarithmic quantities – logarithms of the squared ratio of two pressures, the numerator being the pressure of the sound source of interest, and the denominator being the reference pressure (the quietest sound we can hear).

The logarithmic conversion of sound pressure to SPL means that the quietest sound we can hear (the reference pressure) has a SPL of about zero dB, while the loudest sounds we hear without pain have SPLs of about 120 dB. Most sounds in our day-to-day environment have SPLs from 30 to 100 dB.

Because decibels are logarithmic quantities, they do not behave like regular numbers with which we are more familiar. For example, if two sound sources each produce 100 dB and they are operated together, they produce only 103 dB – not 200 dB as we might expect. Four equal sources operating simultaneously result in a total SPL of 106 dB. In fact, for every doubling of the number of equal sources, the SPL goes up another three decibels. A tenfold increase in the number of sources makes the SPL go up 10 dB. A hundredfold increase makes the level go up 20 dB, and it takes a thousand equal sources to increase the level 30 dB.

If one source is much louder than another source, the two sources together will produce the same SPL (and sound to our ears) as if the louder source were operating alone. For example, a 100-dB source plus an 80-dB source produces 100 dB when operating together. The louder source "masks" the quieter one, but if the quieter source gets louder, it will have an increasing effect on the total SPL. When the two sources are equal, as described above, they produce a level 3 dB above the sound of either one by itself.

From these basic concepts, note that one hundred 80 dB sources will produce a combined level of 100 dB; if a single 100-dB source is added, the group will produce a total SPL of 103 dB. Clearly, the loudest source has the greatest effect on the total decibel level.

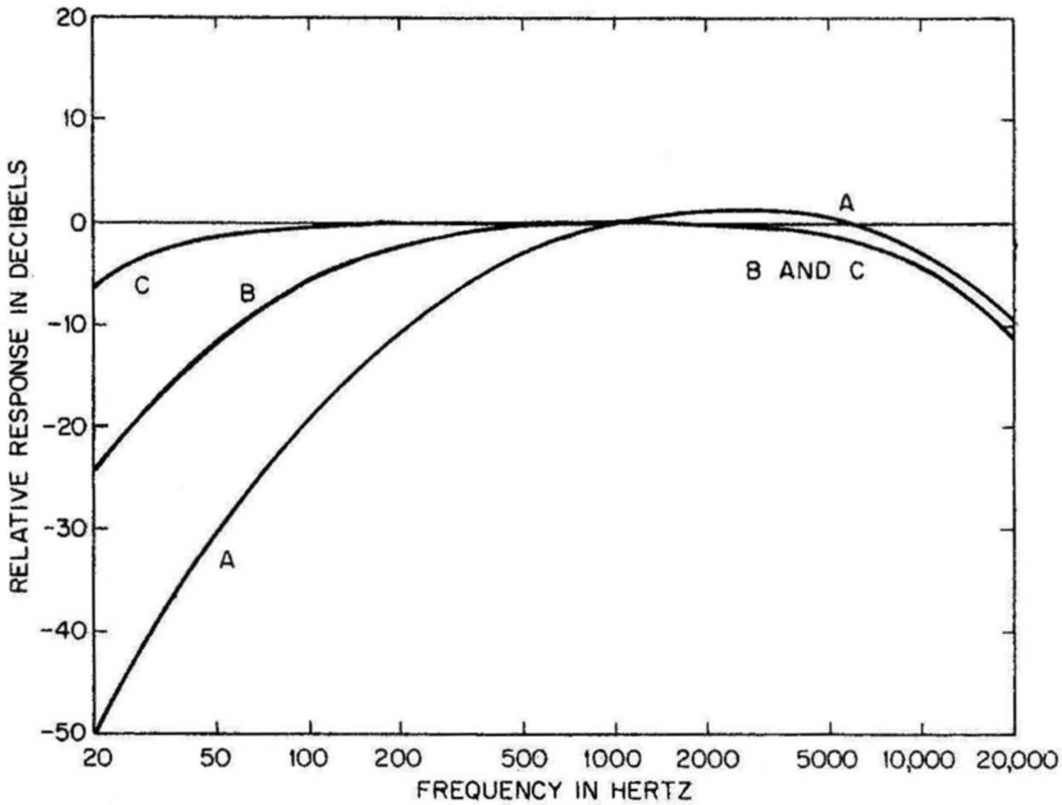
A-Weighted Decibel (dBA)

Another important characteristic of sound is its frequency, or "pitch." This is the rate of repetition of the sound pressure oscillations as they reach our ear. Formerly expressed in cycles per second, frequency is now expressed in units known as Hertz (Hz).

Most people hear from about 20 Hz to about 10,000 to 15,000 Hz. People respond to sound most readily when the predominant frequency is in the range of normal conversation, around 1,000 to 2,000 Hz. Acousticians have developed "filters" to match our ears' sensitivity and help us to judge the relative loudness of sounds made up of different frequencies. The so-called "A" filter does the best job of matching the sensitivity of our ears to most environmental noises. SPLs measured through this filter are referred to as A-weighted levels (dBA). A-weighting significantly de-emphasizes noise at low and very high frequencies (below about 500 Hz and above about 10,000 Hz) where we do not hear as well. Because this filter generally matches our ears' sensitivity, sounds having higher A-weighted sound levels are usually judged louder than those with lower A-weighted sound levels, a relationship which does not always hold true for unweighted levels. It is for these reasons that A-weighted sound levels are normally used to evaluate environmental noise.

Other weighting networks include the B and C filters. They correspond to different level ranges of the ear. The rarely used B-weighting attenuates low frequencies (those less than 500 Hz), but to a lesser degree than A-weighting. C weighting is nearly flat throughout the audible frequency range, hardly de-emphasizing low frequency noise. C-weighted levels can be preferable in evaluating sounds whose low-frequency components are responsible for secondary effects such as the shaking of a building, window rattle, or perceptible vibrations. Uses include the evaluation of blasting noise, artillery fire, and in some cases, aircraft noise inside buildings. **Figure H-1** compares these various weighting networks.

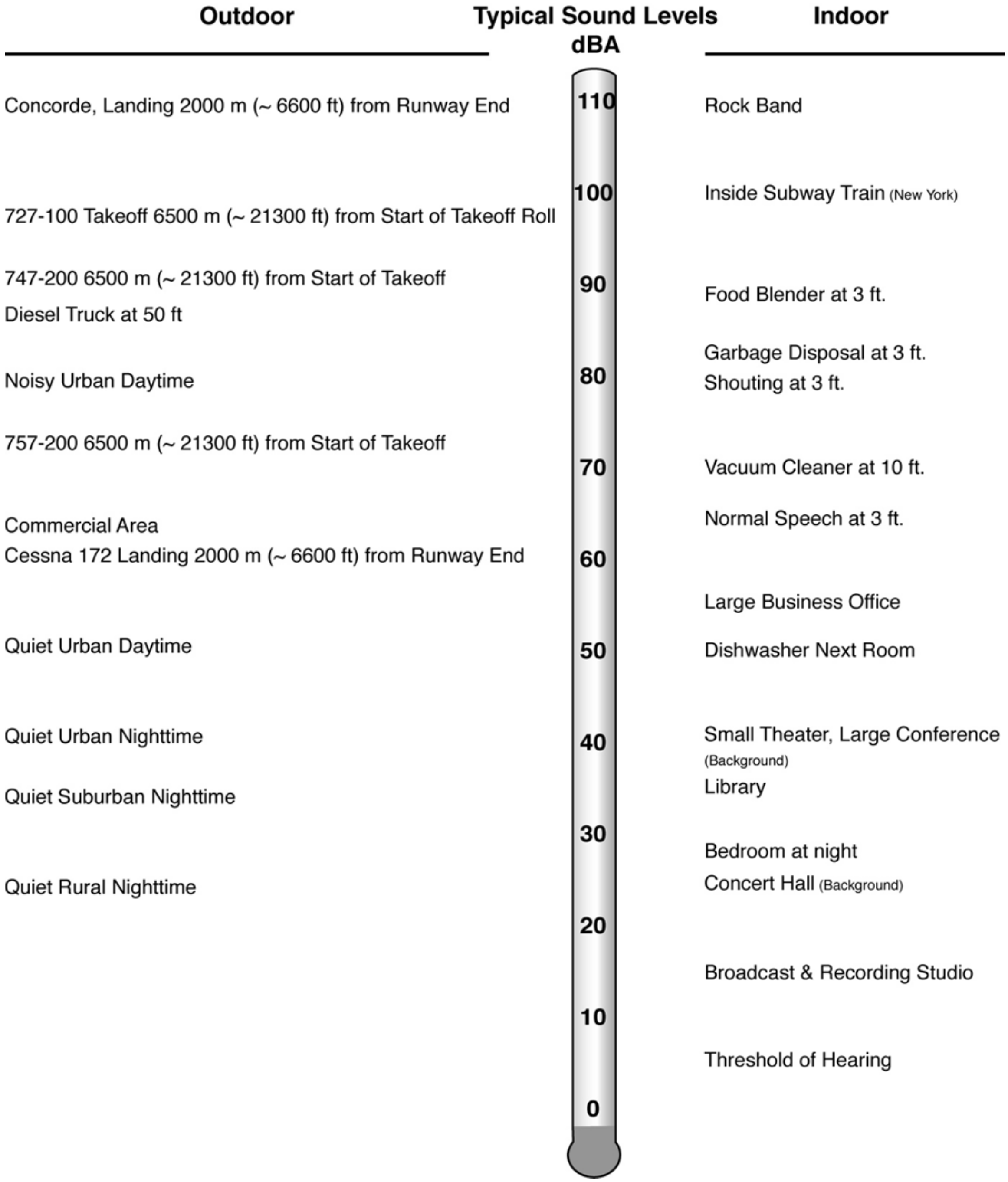
Figure H-1 Frequency-Response Characteristics of Various Weighting Networks



Source: Harris, Cyril M., editor; Handbook of Acoustical Measurements and Noise Control, (Chapter 5, "Acoustical Measurement Instruments"; Johnson, Daniel L.; Marsh, Alan H.; and Harris, Cyril M.); New York; McGraw-Hill, Inc.; 1991; p. 5.13.

Because of the correlation with our hearing, the A-weighted level has been adopted as the basic measure of environmental noise by the U.S. Environmental Protection Agency (EPA) and by nearly every other federal and state agency concerned with community noise. **Figure H-2** presents typical A-weighted sound levels of several common environmental sources.

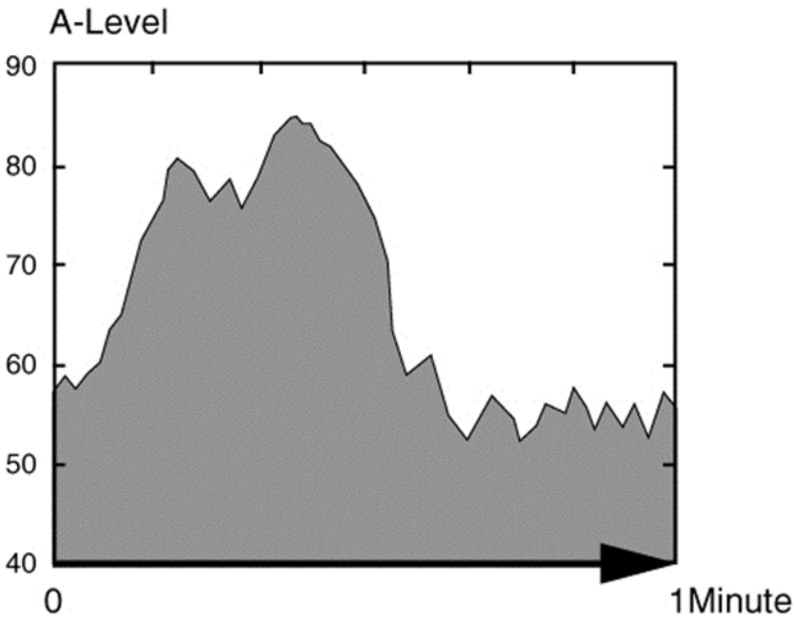
Figure H-2 Common Environmental Sound Levels, in dBA



Source: HMMH (Aircraft noise levels from FAA Advisory Circular 36-3H)
Note: dBA – A-weighted decibel.

An additional dimension to environmental noise is that A-weighted levels vary with time. For example, the sound level increases as an aircraft approaches, then falls and blends into the background as the aircraft recedes into the distance (though even the background varies as birds chirp or the wind blows or a vehicle passes by). **Figure H-3** illustrates this concept.

Figure H-3 Variations in the A-Weighted Sound Level Over Time



Source: HMMH.

Maximum A-Weighted Noise Level (L_{max})

The variation in noise level over time often makes it convenient to describe a particular noise "event" by its maximum sound level, abbreviated as L_{max}. In the figure above, it is approximately 85 dBA.

The maximum level describes only one dimension of an event; it provides no information on the cumulative noise exposure. In fact, two events with identical maxima may produce very different total exposures. One may be of very short duration, while the other may continue for an extended period and be judged much more annoying. The next measure corrects for this deficiency.

Sound Exposure Level (SEL)

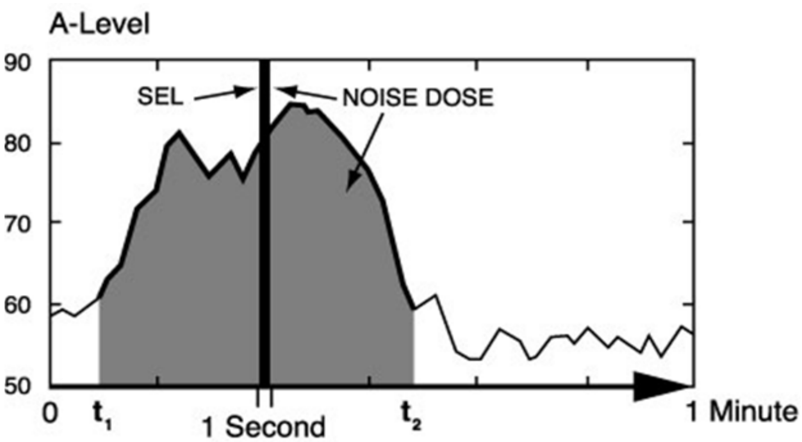
The most frequently used measure of noise exposure for an individual aircraft noise event (and the measure that Part 150[1] specifies for this purpose) is the SEL. SEL is a measure of the total noise energy produced during an event, from the time when the A-weighted sound level first exceeds a threshold level (normally just above the background or ambient noise) to the time that the sound level drops back down below the threshold. To allow comparison of noise events with very different durations, SEL "normalizes" the duration in every case to one second; that is, it is expressed as the steady noise level with just a

1 "Part 150" refers to Federal Aviation Regulations (FAR) Part 150, discussed in detail in the Regulatory Framework Section of this Appendix.

one-second duration that includes the same amount of noise energy as the actual longer duration, time-varying noise. In lay terms, SEL “squeezes” the entire noise event into one second.

Figure H-4 depicts this transformation. The shaded area represents the energy included in an SEL measurement for the noise event, where the threshold is set to 60 dBA. The dark shaded vertical bar, which is 90 dBA high and just one second long (wide), contains the same sound energy as the full event.

Figure H-4 Sound Exposure Level (SEL)



Source: HMMH.

Because the SEL is normalized to one second, it will always be larger than the L_{max} for an event longer than one second. In this case, the SEL is 90 dB; the L_{max} is approximately 85 dBA. For most aircraft overflights, the SEL is normally on the order of 7 to 12 dB higher than L_{max}. Because SEL considers duration, longer exposure to relatively slow, quiet aircraft, such as propeller models, can have the same or higher SEL than shorter exposure to faster, louder planes, such as corporate jets.

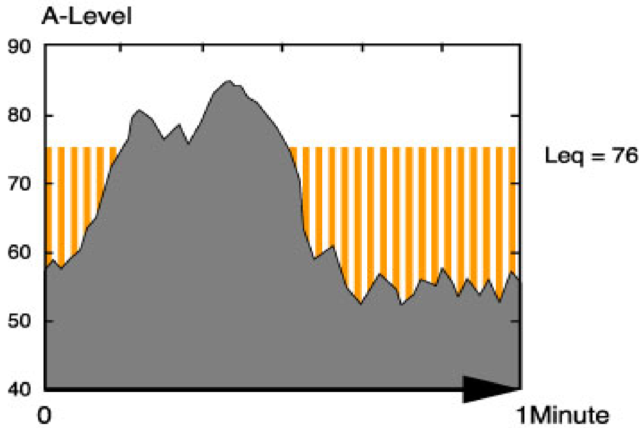
Equivalent Sound Level (L_{eq})

The L_{max} and SEL quantify the noise associated with individual events. The remaining metrics in this section describe longer-term cumulative noise exposure that can include many events.

The Equivalent Sound Level (L_{eq}) is a measure of exposure resulting from the accumulation of A-weighted sound levels over a particular period of interest (e.g., an hour, an eight-hour school day, nighttime, or a full 24-hour day). Because the length of the period can differ, the applicable period should always be identified or clearly understood when discussing the metric. Such durations are often identified through a subscript, for example $L_{eq(8)}$ or $L_{eq(24)}$.

L_{eq} is equivalent to the constant sound level over the period of interest that contains as much sound energy as the actual time-varying level. This is illustrated in **Figure H-5**. Both the solid and striped shaded areas have a one-minute L_{eq} value of 76 dB. It is important to recognize, however, that the two signals (the constant one and the time-varying one) would sound very different in real life. Also, be aware that the "average" sound level suggested by L_{eq} is not an arithmetic value, but a logarithmic, or "energy-averaged" sound level. Thus, loud events dominate L_{eq} measurements.

Figure H-5 Example of a One Minute Equivalent Sound Level (L_{eq})



Source: HMMH.

In airport noise studies, L_{eq} is often presented for consecutive one-hour periods to illustrate how the exposure rises and falls throughout a 24-hour period, and how individual hours are affected by unusual activity, such as rush hour traffic or a few loud aircraft.

Time Above (TA)

TA is a metric that gives the duration, in minutes, for which aircraft-related noise exceeds a specified A-weighted sound level during a given period. The measure is referred to generally as TA. For this *2017 ESPR*, three threshold sound levels are used in the analysis: 65, 75, and 85 dBA. These times are computed using the Federal Aviation Administration (FAA)-approved Integrated Noise Model (INM).

Time Above Night (TAN)

Identical to TA, except it is computed for only the 9-hour period between 10:00 PM and 7:00 AM. The TAN is also developed using three threshold sound levels 65, 75, and 85 dBA.

Day-Night Average Sound Level (DNL)

Virtually all studies of aircraft noise rely on a slightly more complicated measure of noise exposure that describes cumulative noise exposure during an average annual day: the DNL. The EPA identified DNL as the most appropriate means of evaluating airport noise based on the following considerations:[2]

1. The measure should be applicable to the evaluation of pervasive long-term noise in various defined areas and under various conditions over long periods.

2. The measure should correlate well with known effects of the noise environment and on individuals and the public.

2 Information on Levels of Environmental Noise Requisite to Protect Public Health and Welfare with an Adequate Margin of Safety," U. S. EPA Report No. 550/9-74-004, March 1974.

3. The measure should be simple, practical, and accurate. In principal, it should be useful for planning as well as for enforcement or monitoring purposes.

4. The required measurement equipment, with standard characteristics, should be commercially available.

5. The measure should be closely related to existing methods currently in use.

6. The single measure of noise at a given location should be predictable, within an acceptable tolerance, from knowledge of the physical events producing the noise.

7. The measure should lend itself to small, simple monitors, which can be left unattended in public areas for long periods.

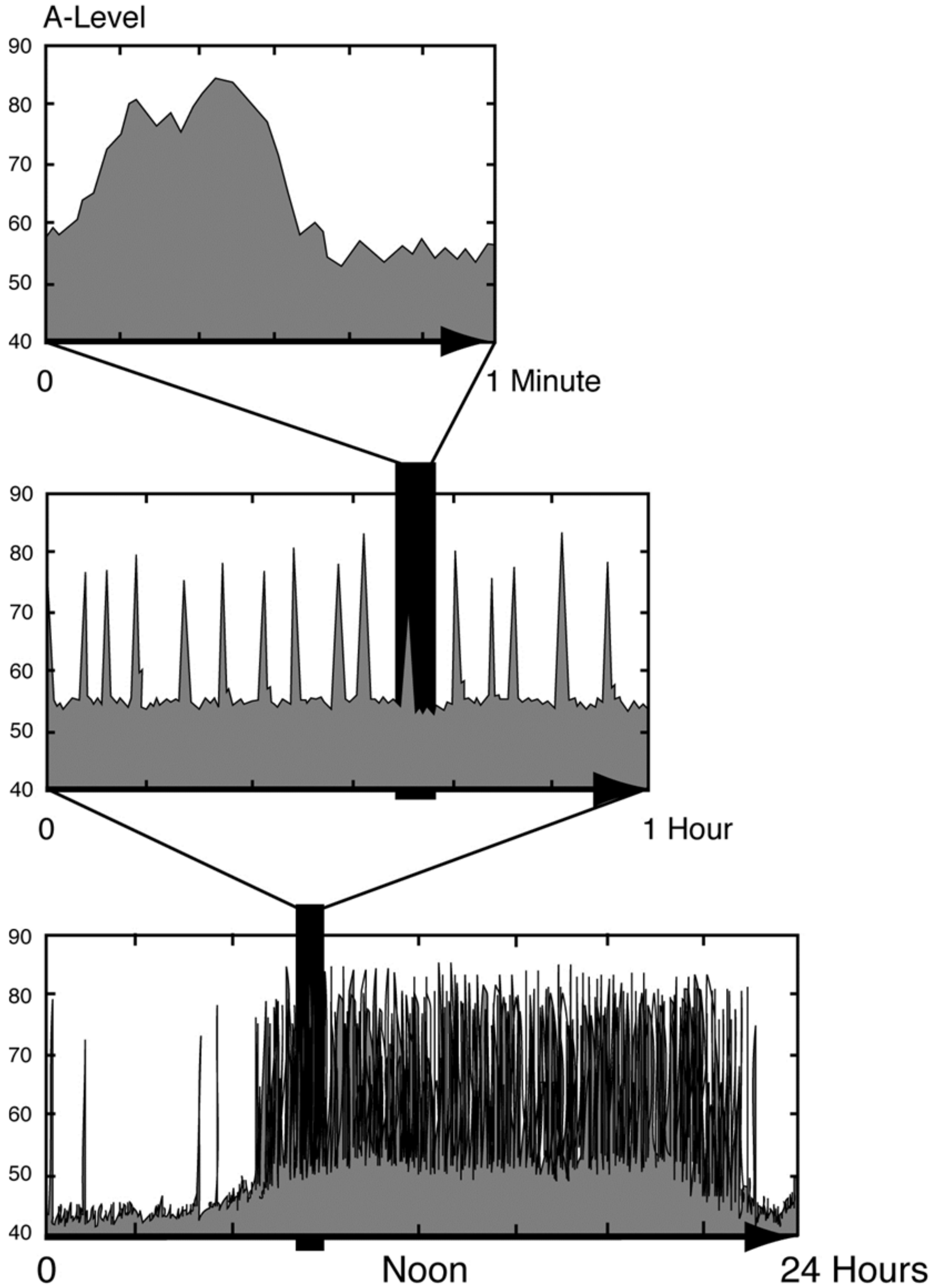
Most federal agencies dealing with noise have formally adopted DNL. The Federal Interagency Committee on Noise (FICON) reaffirmed the appropriateness of DNL in 1992. The FICON summary report stated; "There are no new descriptors or metrics of sufficient scientific standing to substitute for the present DNL cumulative noise exposure metric."

The DNL represents noise as it occurs over a 24-hour period, with one important exception: DNL treats nighttime noise differently from daytime noise. In determining DNL, it is assumed that the A-weighted levels occurring at night (defined as 10:00 PM to 7:00 AM) are 10 dB louder than they really are. This 10-dB penalty is applied to account for greater sensitivity to nighttime noise, and the fact that events at night are often perceived to be more intrusive because nighttime ambient noise is less than daytime ambient noise.

Figure H-4 illustrated the A-weighted sound level due to an aircraft fly-over as it changed with time. The top frame of **Figure H-6** repeats this figure. The shaded area reflects the noise dose that a listener receives during the one-minute period of the sample. The center frame of **Figure H-6** includes this one-minute sample within a full hour. The shaded area represents the noise during that hour with 16 noise events, each producing an SEL. Similarly, the bottom frame includes the one-hour interval within a full 24 hours. Here the shaded area represents the listener's noise dose over a complete day. Note that several overflights occur at a time when the background noise drops some 10 dB, to approximately 45 dBA.

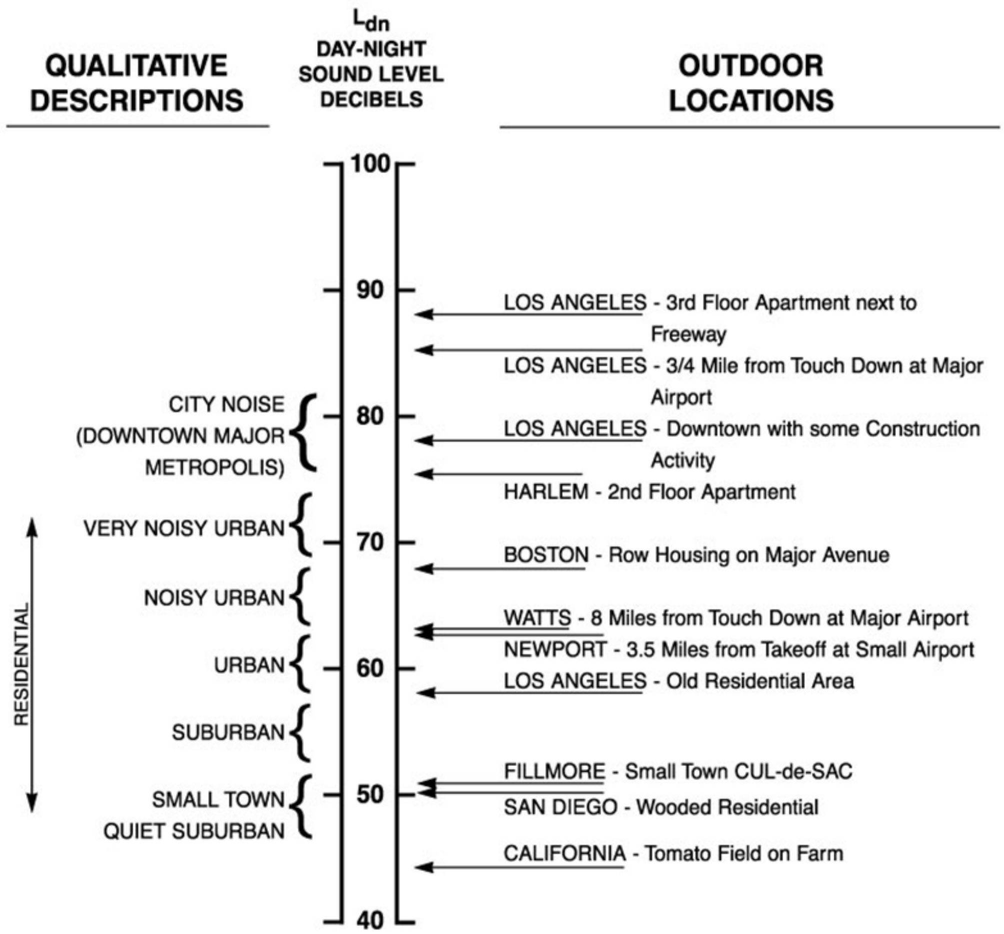
DNL can be measured or estimated. Measurements are practical only for obtaining DNL values for relatively limited numbers of points, and, in the absence of a permanently installed monitoring system, only for relatively short time periods. Most airport noise studies are based on computer-generated DNL estimates, determined by accounting for all the SELs from individual events, which comprise the total noise dose at a given location. Computed DNL values are often depicted in terms of equal-exposure noise contours (much as topographic maps have contours of equal elevation). **Figure H-7** depicts typical DNL values for a variety of noise environments.

Figure H-6 Daily Noise Dose



Source: HMMH.

Figure H-7 Examples of Day-Night Average Sound Levels (DNL)



Source: U.S. Environmental Protection Agency (EPA), Information on Levels of Environmental Noise Requisite to Protect Public Health and Welfare with an Adequate Margin of Safety, March 1974, p. 14.

As of May 2015, FAA is beginning work on the next step in a multi-year Noise Research Program that will update the scientific evidence on the relationship between aircraft noise exposure and its effects on communities around airports. If changes are warranted, FAA will propose revised policy and related guidance and regulations, subject to interagency coordination, as well as public review and comment.

The Effects of Aircraft Noise on People

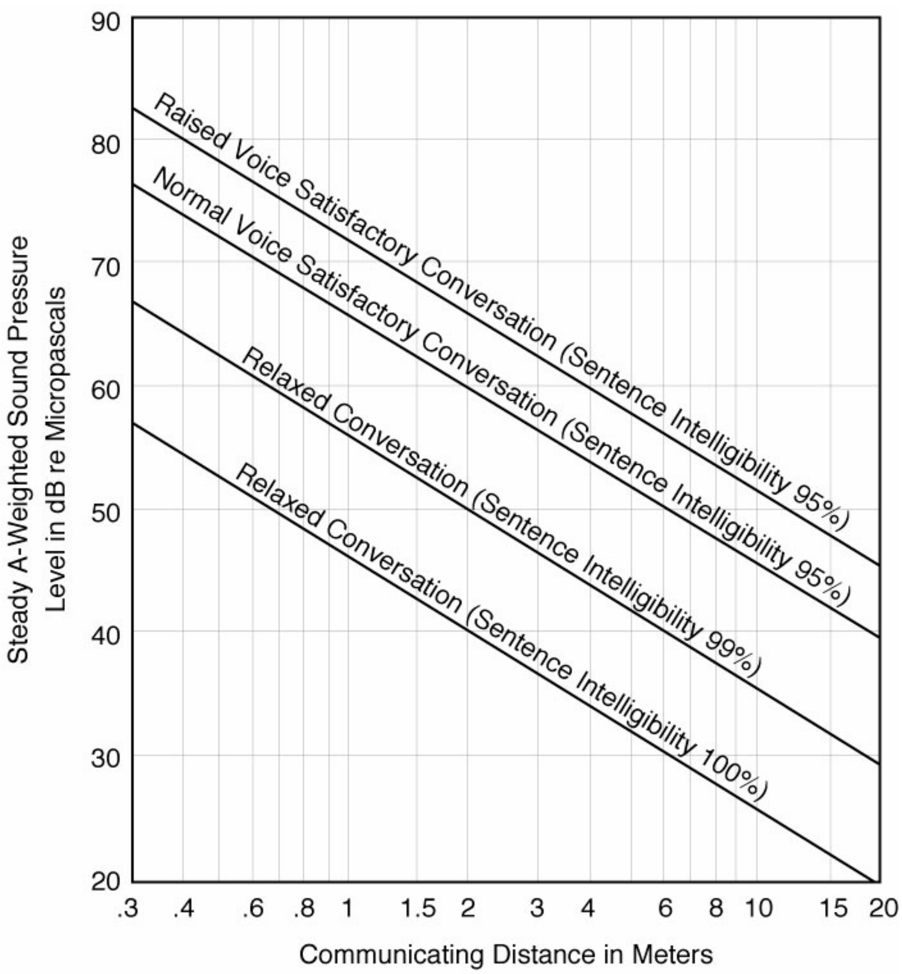
To residents around airports, aircraft noise can be an annoyance and a nuisance. It can interfere with conversation and listening to television, it can disrupt classroom activities in schools, and it can disrupt sleep. Relating these effects to specific noise metrics helps in the understanding of how and why people react to their environment.

Speech Interference

A primary effect of aircraft noise is its tendency to drown out or "mask" speech, making it difficult to carry on a normal conversation. The sound level of speech decreases as the distance between a talker and

listener increases. As the background sound level increases, it becomes harder to hear speech. **Figure H-8** presents typical distances between talker and listener for satisfactory outdoor conversations, in the presence of different steady A-weighted background noise levels for raised, normal, and relaxed voice effort. As the background level increases, the talker must raise his/her voice, or the individuals must get closer together to continue talking.

Figure H-8 Outdoor Speech Intelligibility



Source: U.S. Environmental Protection Agency (EPA), Information on Levels of Environmental Noise Requisite to Protect Public Health and Welfare with an Adequate Margin of Safety, March 1974, p. D-5.

As indicated in the figure, "satisfactory conversation" does not always require hearing every word; 95 percent intelligibility is acceptable for many conversations. Listeners can infer a few unheard words when they occur in a familiar context. However, in relaxed conversation, we have higher expectations of hearing speech and generally require closer to 100 percent intelligibility. Any combination of talker-listener distances and background noise that falls below the bottom line in **Figure H-8** (thus assuring 100 percent intelligibility) represents an ideal environment for outdoor speech communication and is considered necessary for acceptable indoor conversation as well.

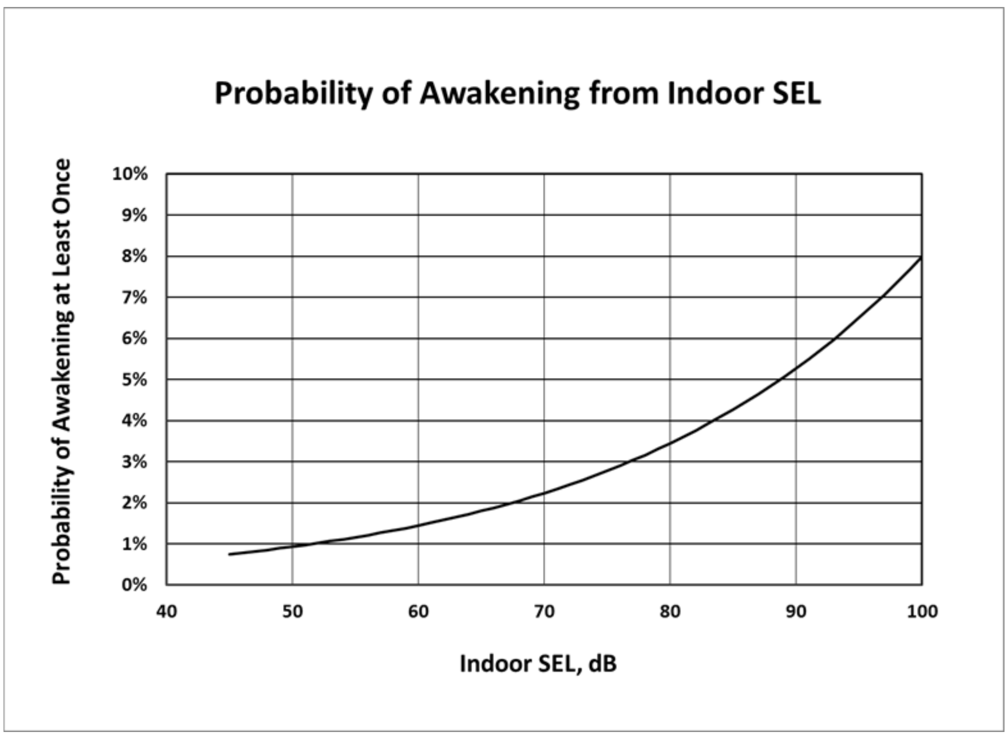
One implication of the relationships in **Figure H-8** is that for typical communication at distances of 3 or 4 feet (1 to 1.5 meters), acceptable outdoor conversations can be carried on in a normal voice as long as the background noise outdoors is less than about 65 dBA. If the noise exceeds this level, as might occur when an aircraft passes overhead, intelligibility would be lost unless vocal effort were increased, or communication distance were decreased.

Indoors, typical distances, voice levels, and intelligibility expectations generally require a background level less than 45 dBA. With windows partly open, housing generally provides about 12 dBA of interior-to-exterior noise level reduction. Thus, if the outdoor sound level is 60 dBA or less, there is a reasonable chance that the resulting indoor sound level will afford acceptable conversation inside. With windows closed, 24 dB of attenuation is typical.

Sleep Interference

Research on sleep disruption from noise has led to widely varying observations. In part, this is because (1) sleep can be disturbed without awakening, (2) the deeper the sleep the more noise it takes to cause arousal, and (3) the tendency to awaken increases with age, and other factors. **Figure H-9** shows one such relationship from recent research conducted in the U.S. – the probability that a group of people will be awakened at least once when exposed to a given indoor SEL.

Figure H-9 Probability of Awakening at Least Once from Indoor Noise Event



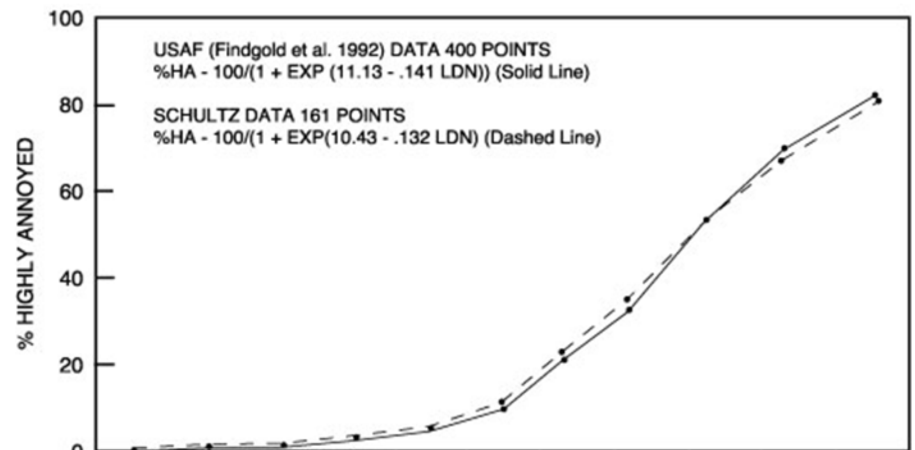
Source: American National Standards Institute (ANSI) S12.9-2008/Part 6, Quantities and Procedures for Description and Measurement of Environmental Sound — Part 6: Methods for Estimation of Awakenings Associated with Outdoor Noise Events Heard in Homes; Equation 1.

For example, an indoor SEL of 80 dB results in approximately 3.5 percent of the exposed population being awakened. If windows are open in the bedroom on a warm evening and a house provides a typical outside-to-inside noise level reduction of around 15 dB, which suggests it takes an SEL of about 95 dB outdoors to awaken 3.5 percent of the population. The American National Standards Institute (ANSI) has extended this concept further and developed a standard (ANSI S12.9-2008/Part 6) for computing the percentage of the population that is likely to be awakened by multiple noise events occurring throughout the night. The Federal Interagency Committee on Aviation Noise (FICAN) subsequently endorsed the standard as the best available means of estimating behavioral awakenings from aircraft noise.

Community Annoyance

Social survey data make it clear that individual reactions to noise vary widely for a given noise level. Nevertheless, as a group, people's aggregate response is predictable and relates well to measures of cumulative noise exposure such as DNL. **Figure H-10** shows a widely recognized relationship between environmental noise and annoyance.

Figure H-10 Percentage of People Highly Annoyed



Day - Night Average Sound Level in dB		40	45	50	55	60	65	70	75	80	85	100
Calculated %HA Points	USAF	0.41	0.831	1.66	3.31	6.48	12.29	22.1	36.47	53.74	70.16	82.64
	SCHULTZ	0.576	1.11	2.12	4.03	7.52	13.59	23.32	37.05	53.25	68.78	81

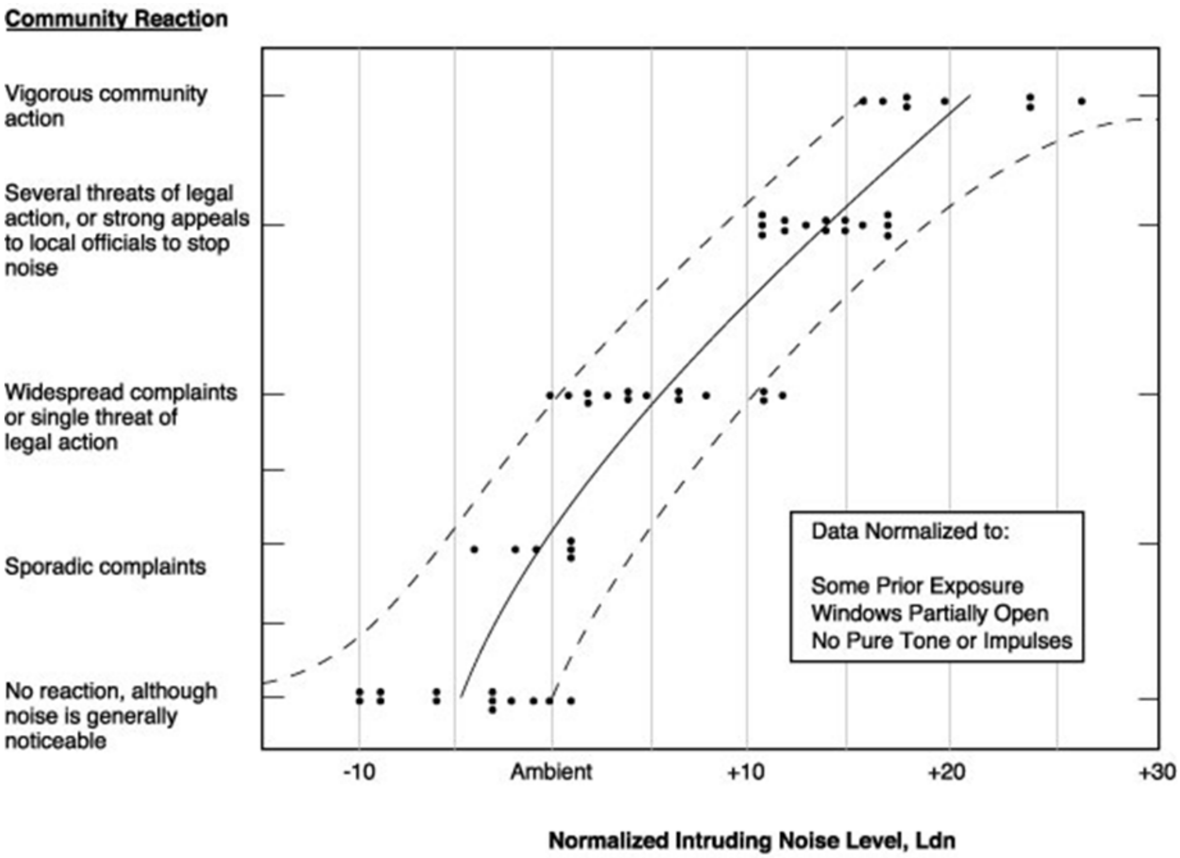
Source: Federal Interagency Committee on Aviation Noise (FICON). "Federal Agency Review of Selected Airport Noise Analysis Issues." August 1992. (From data provided by USAF Armstrong Laboratory). pp. 3-6.

Based on data from 18 surveys conducted worldwide, the curve indicates that at levels as low as DNL 55, approximately 5.0 percent of the people will still be highly annoyed, with the percentage increasing more rapidly as exposure increases above DNL 65.

Separate work by the EPA has shown that overall community reaction to a noise environment can also be related to DNL. This relationship is shown in **Figure H-11**. Levels have been normalized to the same set of exposure conditions to permit valid comparisons between ambient noise environments. Data summarized in **Figure H-11** suggest that little reaction would be expected for intrusive noise levels five decibels below

the ambient, while widespread complaints can be expected as intruding noise exceeds background levels by about 5 dB. Vigorous action is likely when the background is exceeded by 20 dB.

Figure H-11 Community Reaction as a Function of Outdoor DNL



Source: Wyle Laboratories, "Community Noise," prepared for the U.S. Environmental Protection Agency, Office of Noise Abatement and Control, Washington, D.C., December 1971, pg. 63.
Note: DNL - Day-Night Average Sound Level.

Regulatory Framework

Logan Airport Noise Abatement Rules and Regulations

Massport's primary mechanism for reducing noise impacts from Logan Airport's operations is the Noise Rules.[3] The Noise Rules were designed to reduce noise impacts by encouraging use of quieter aircraft by requiring decreased use of noisier aircraft and by limiting nighttime activity by louder Stage 2 types. Many secondary goals aimed at limiting noise in specific areas also were stated.

Specific provisions of the Noise Rules, which continue to serve these goals, include:

- Limiting cumulative noise exposure at Logan Airport (as measured by Massport's cumulative noise index [CNI]) to a maximum of 156.5 Effective Perceived Noise Decibels (EPNdB);

3 The Logan International Airport Noise Abatement Rules and Regulations, effective July 1, 1986, are codified at 740 Code of Massachusetts Regulations (CMR) 24.01 et seq (also known as the Noise Rules).

- Maximizing use of Stage 3 aircraft;
- Restricting nighttime operations by Stage 2 aircraft;
- Placing limitations on times and locations of engine run-ups and use of auxiliary power units (APU); and
- Restricting use of certain runways by noisier aircraft and time of day.

These restrictions and limitations are subject to FAA implementation and safe operation of the airport and airspace.

Federal Aviation Regulation (FAR) Part 36

Logan Airport operates within a framework of federal aviation regulations that limits an airport operator's ability to control noise. For example, FAA's FAR Part 36[4] sets noise limits for aircraft certification and the procedures by which aircraft noise emission levels must be measured to determine compliance. The regulation defines noise emission limits for turbojets, turboprops, and helicopters, classifying turbojets into categories referred to as stages based on noise levels at each of three locations: takeoff, landing, and to the side of the runway during takeoff (sideline). The categories are:

- Stage 1 aircraft are the oldest and usually have the loudest operations, having preceded the existence of any noise emission regulation. Rare examples include old, restored civil or military aircraft. There are no Stage 1 aircraft operating at Logan Airport.
- Stage 2 aircraft are less old and less noisy than Stage 1; they were the first aircraft types required to meet a noise limit. A subsequent regulation, FAR Part 91 (described below), prohibits the operation of a Stage 2 aircraft in the continental U.S. unless its takeoff weight is 75,000 pounds or less. FAA Reauthorization bill of 2012 also mandated the phase out of Stage 2 aircraft with a takeoff weight less than 75,000 pounds by the end of 2015. Thus, there are no longer any Stage 2 aircraft operating at Logan Airport.
- Stage 3 aircraft were certified for service before 2006 and have relatively quiet jets, although some are Stage 2 aircraft that have been re-engined, or have been fitted with hushkits, enabling them to meet Stage 3 noise limits.
- Stage 4 aircraft are required to operate with a cumulative noise level at least 10 dB quieter than Stage 3 aircraft at three prescribed measurement points. Jet aircraft certificated after January 1, 2006 must meet the Stage 4 limits. Although not required, the majority of aircraft in the 2017 Logan Airport fleet would also meet the Stage 4 noise limits if they were recertificated.
- Stage 5 aircraft are the newest and quietest aircraft. All aircraft certificated after January 1, 2018 must meet Stage 5 limits, which are a cumulative 7 dB below Stage 4 and 17 dB below Stage 3 aircraft. The Boeing 787, 747-8, and Airbus A350 and A380 are examples of aircraft that meet the new limits. About 18 percent of aircraft in the 2017 Logan Airport fleet would meet Stage 5 noise limits.

4 14 CFR Part 36, "Noise Standards: Aircraft Type and Air Worthiness Certification."

FAR Part 150

First implemented in February 1981, FAR Part 150[5] defines procedures that an airport operator must follow if it chooses to conduct and implement an airport noise and land use compatibility plan. Part 150 Noise Compatibility studies require the use of DNL to evaluate the airport noise environment. FAR Part 150 identifies noise compatibility guidelines for different land uses depending on their sensitivity. Key values include a DNL of 75 dB, above which no residences, schools, hospitals, or churches are considered compatible, and a DNL of 65 dB, above which those land uses are considered compatible only if they are sound insulated.

Noise abatement or mitigation measures that an airport operator must consider in a Part 150 study include acquisition of incompatible land, construction of noise barriers, sound insulation of buildings, implementation of a preferential runway program, use of noise abatement flight tracks, implementation of airport use restrictions, and any other actions that would have a beneficial effect on the public.

While Massport has implemented variations of these and additional measures at Logan Airport, Massport has not filed an official Part 150 noise compatibility study with FAA because all of Logan Airport's program elements, while regularly reviewed and updated, preceded the promulgation of Part 150 and are effectively grandfathered under the regulation.

FAR Parts 91 and 161

The Airport Noise and Capacity Act of 1990 (ANCA)[6] directed the U.S. Secretary of Transportation to undertake three key noise-related actions:

- Establish a schedule for a phase out of Part 36 Stage 2 aircraft by the year 2000;
- Establish a program for FAA review of all new airport noise and access restrictions limiting operations of Stage 2 aircraft; and
- Establish a program for FAA review and approval of any restriction that limits operations of Stage 3 aircraft, including public notice requirements.

FAA addressed these requirements through amendment of an existing federal regulation, "Part 91,"[7] and establishment of a new regulation, "Part 161."[8] ANCA effectively ended Massport's pursuit of any additional operational restrictions outside of this program.

Amendment to Part 91

FAA establishes and regulates operating noise limits for civil aircraft operation in Subpart I, "Operating Noise Limits," of 14 CFR Part 91, "General Operating and Flight Rules." The noise limits are based on aircraft noise certification criteria set forth in 14 CFR Part 36, described above.

In 1976, FAA ordered a phase out of all Stage 1 aircraft with a maximum gross takeoff weight (MGTOW) over 75,000 pounds, to be completed on January 1, 1985. After that date, Stage 1 civil aircraft over

5 14 CFR Part 150, "Airport Noise Compatibility Planning."
6 Pub. L. No. 101-508, 104 Stat. 1388, as recodified at 49 United States Code 47521- 47533.
7 14 CFR Part 91, "General Operating and Flight Rules."
8 14 CFR Part 161, "Notice and Approval of Airport Noise and Access Restrictions."

75,000 pounds MGTOW were banned from operating in the U.S. (with limited exemptions related to commercial service at "small communities," which has since expired in 1988). ANCA required a similar phase out of Stage 2 aircraft over 75,000 pounds by December 31, 1999. The 75,000-pound weight limit exempted most "business" (or "corporate") jets and a very small number of the very smallest "air carrier" type jets until December 31, 2015 when a full ban took effect.[9] Aircraft operators responded to the Stage 1 and 2 phase-outs by retiring their non-compliant aircraft or modifying some of their aircraft to meet the more stringent standards. The modifications undertaken include installation of quieter engines, noise-reducing physical modifications to the airframe and/or existing engines, and limitation of operating weights and procedures to meet the applicable Part 36 limits. Some former Stage 2 airline aircraft that were "recertificated" as Stage 3 with these modifications still operate at Logan Airport, but are generally declining due to the aircrafts' age and high operating costs (in particular due to the generally low fuel efficiency of these older aircraft).

From 2006 to 2017, as airlines add new aircraft, Stage 4 aircraft have been added to their fleets. The Stage 4 noise standard applies to any new jet aircraft type designs over 12,500 pounds requiring FAA approval after January 1, 2006. The International Civil Aviation Organization (ICAO) has also adopted the same regulation for international operators, but neither FAA nor ICAO have indicated there will be restrictions on the remaining recertificated Stage 3 aircraft from carrier fleets.

ICAO and FAA have adopted a higher standard of noise classification called Stage 5 (Chapter 14 for ICAO) which will be effective for new aircraft type certification after December 31, 2017 and December 31, 2020, depending on the weight of the aircraft.[10]

Part 161

FAA implemented the ANCA requirements related to notice, analysis, and approval of use restrictions affecting Stage 2 and 3 aircraft through the establishment of a new regulation, 14 CFR Part 161, "Notice and Approval of Airport Noise and Access Restrictions." In simple terms, Part 161 requires an airport operator that proposes to implement a restriction on Stage 2 or 3 aircraft operations to undertake, document, and publicize certain benefit-cost analyses, comparing the noise benefits of the restriction to its economic costs. Operators must obtain specific FAA approvals of the analysis, documentation, and notice processes, and – for Stage 3 restrictions – approval of the restriction itself.

Part 161 and ANCA define more demanding requirements and explicit guidance for Stage 3 restrictions. To implement a Stage 3 restriction, formal FAA approval is required. FAA's role for Stage 2 restrictions is limited to commenting on compliance with Part 161 notice and analysis procedural requirements. Part 161 provides guidance regarding appropriate information to provide in support of these findings. While Part 161 does not require this information for a Stage 2 restriction, Part 161 states that it would be "useful." Moreover, FAA has required airports to provide this same information for Stage 2 restrictions (and even for Stage 1 restrictions pursued under FAR Part 150), on the grounds that they are required for airports to comply with grant assurance 22(a), "Economic Nondiscrimination," which states that an airport operator "will make its airport available as an airport for public use on reasonable terms and without

9 FAA Modernization and Reform Act of 2012 sets a January 1, 2016 ban of Stage 2 aircraft less than 75,000 lbs.

10 The Final Rule was published on October 4, 2017.

unjust discrimination to all types, kinds, and classes of aeronautical activities, including commercial aeronautical activities offering services to the public at the Airport."[11]

Although several (on the order of a dozen) airports have embarked on efforts to adopt both Stage 2 and 3 restrictions in the past two decades, FAA has found that only one, Naples Municipal Airport, a general aviation (GA) airport in Naples, Florida, has fully complied with Part 161 analysis, notice, and documentation requirements for a ban on Stage 2 jet operations. FAA found the airport was in violation of prior to FAA grant assurances. The airport operator successfully sued FAA to overturn that ruling and has implemented the restriction.

ANCA and Part 161 specifically exempt Stage 3 use restrictions that were effective on or before October 1, 1990 and Stage 2 restrictions that were proposed before that date. The Logan Airport Noise Rules were promulgated in 1986; therefore, ANCA and Part 161 have no bearing on their continued implementation in their current form. Any future proposals to make the rules more stringent regarding Stage 2 operations or to restrict Stage 3 operations in any way would almost certainly trigger Part 161 notice, analysis, and approval processes for Stage 3 restrictions. In 2006, Massport requested an opinion from FAA regarding the pursuit of a Part 161 waiver or exemption to allow Massport to implement a curfew of nighttime operations of hush-kitted Stage 3 aircraft. FAA informed Massport that a waiver or exemption from the requirements of Part 161 is not authorized under, or consistent with, federal statutory and regulatory requirements. A copy of FAA's letter to Massport was provided in Appendix H, *Noise Abatement* in the *2005 Environmental Data Report (EDR).*

Logan Airport Noise Modeling

To relate portions of the foregoing discussion to the specific noise environment around Logan Airport for this *2017 ESPR*, Massport has developed DNL noise contours, TA noise metrics, and population counts for 2017 using the latest version of FAA's Aviation Environmental Design Tool (AEDT version 2d) and the software pre-processor, RC for AEDT™. The pre-processor software takes radar data from individual flights occurring throughout the year, and formats it into a form usable as input to the AEDT which serves as the computational "engine" for calculating noise. Prior to 2016, Massport used the FAA's INM with a pre-processor called RealContours™ which operated in a similar manner.

Standard AEDT input methodology involves development of operational inputs and calculation of the DNL for a prototypical average annual day.[12] This approach requires manually collecting, refining, and entering the enormous amount of data averaged over a full year of activity at an airport. Typically, the model inputs may include an aircraft fleet mix with several dozen representative aircraft types, on the order of 100 to 300 representative flight tracks (common for a facility the size of Logan Airport), and runway use and flight track use percentages for three or four categories of aircraft types with similar performance characteristics. This normal approach to noise modeling meets accepted professional

11 FAA Order 5190.6(b), "Airport Compliance Manual" Chapter 13, Section 14, paragraph (a). To be approved, restrictions must meet the following six statutory criteria: 1) The proposed restriction is reasonable, nonarbitrary, and nondiscriminatory. 2) The proposed restriction does not create an undue burden on interstate or foreign commerce. 3) The proposed restriction maintains safe and efficient use of the navigable airspace. 4) The proposed restriction does not conflict with any existing federal statute or regulation. 5) The applicant has provided adequate opportunity for public comment on the proposed restriction. 6) The proposed restriction does not create an undue burden on the national aviation system.

12 FAA INM Version 7.0 User's Guide, April 2007, p. 12.

standards and reduces the effort and cost that would be associated with manually entering the parameters for every actual operation. However, it represents a significant simplification of the extraordinary diversity of actual aircraft operations over a year.

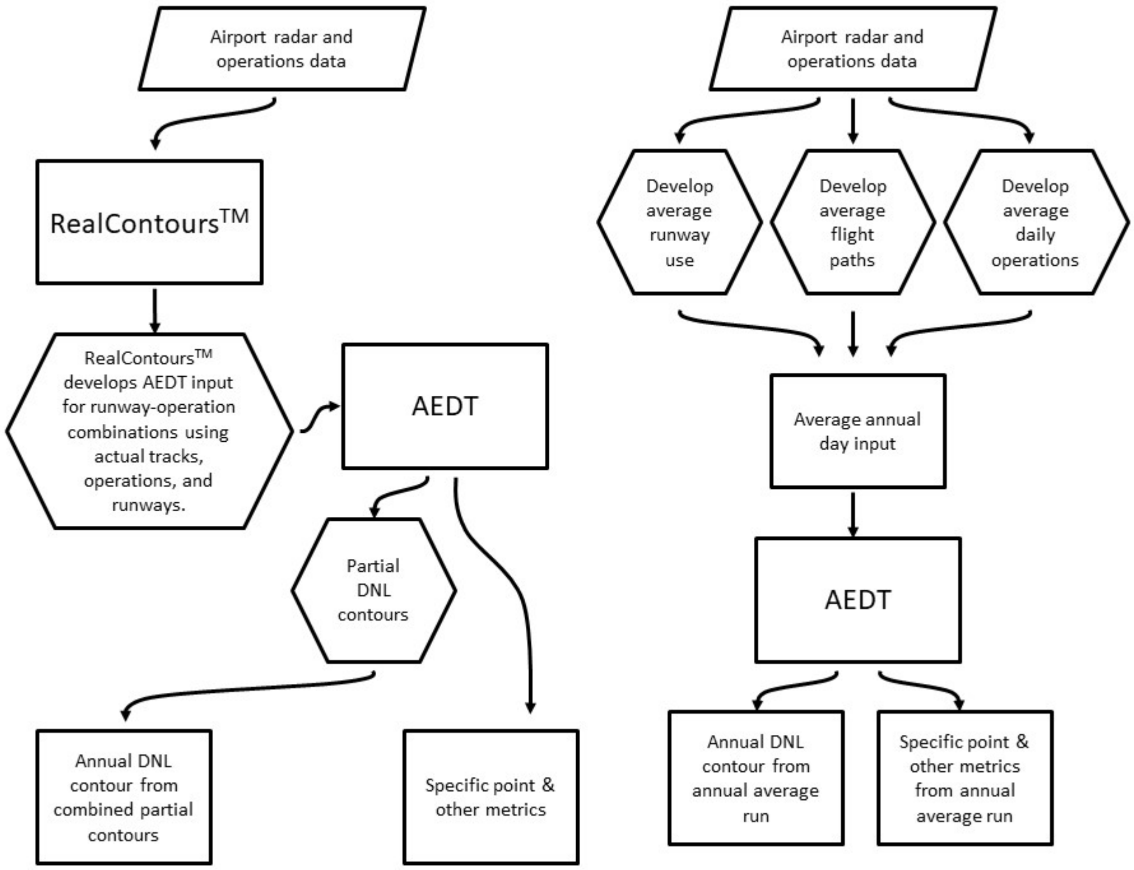
Instead of relying on consolidated data summaries, Massport takes maximum possible advantage of both AEDT's capabilities and the investment that Massport has made in its Noise and Operations Management System (NOMS). RC for AEDT™ improves the precision of modeling by utilizing operations monitoring results in these key areas:

- Directly converts the flight track for every identified aircraft operation to an AEDT track, rather than assigning multiple operations to a limited number of prototypical tracks.
- Models each operation on the specific runway that it actually used, rather than applying a generalized distribution to broad ranges of aircraft types.
- Models each operation in the time period that it occurred, which realistically represent delays that occur during the year, rather than relying on scheduled flight times.
- Selects the specific airframe and engine combination to model, on an operation-by-operation basis, based on the registration data for each flight wherever possible; otherwise, based on the published compositions of the fleets of the specific airlines operating at Logan Airport.

Figure H-12 provides a schematic representation of the RC for AEDT™ noise modeling process compared to the standard AEDT process. The flow chart on the left depicts data from the NOMS system being used as noise model inputs, while the flow chart on the right illustrates the development of a simplified average annual day that would be otherwise necessary.

For 2017, the AEDT noise model used 394,548 flights from the NOMS that retained suitable data.

Figure H-12 Schematic Noise Modeling Process (RC for AEDT™ vs. standard AEDT use)



Source: Federal Aviation Administration (FAA), HMMH.

AEDT Noise Analysis

Logan Airport presents a set of unique challenges to modeling software, and over the course of many years, Massport has addressed these challenges by developing a series of adjustments and customizations to better represent the operations, conditions, and terrain that affect noise at Logan Airport. These adjustments have historically been incorporated into INM analyses:

- ***Custom profiles***. The analysis has developed custom climbing and descent profiles based on radar altitude data, rather than using default profiles built into INM. This results in more accurate aircraft thrust calculations, which in turn affects an aircraft's noise emissions.
- ***Daily weather data***. Noise calculations have used average weather conditions for each day to determine aircraft performance and sound propagation.
- ***Hill effect adjustment***. Due to discrepancies between noise monitor data and INM calculations in the Orient Heights area close to the Airport, adjustments have been included to improve the accuracy of calculations in areas with direct line-of-sight exposure to the airfield.

- ***Over-water adjustment***. The INM calculations assume that noise is absorbed as it propagates over ground. However, Logan Airport is mostly surrounded by water, which reflects rather than absorbs the sound. This results in higher noise levels in areas near the Airport. An adjustment has been used that allows the INM to assume higher aircraft noise emissions when they are close to the ground.

In 2015, FAA released its next-generation environmental analysis software, the AEDT version 2B.[13] AEDT incorporates the computational engines of the legacy tools INM and the Emissions and Dispersion Modeling System (EDMS) and provides a unified database back end and graphical user interface. With a common set of aircraft and airport data that are updated regularly, AEDT ensures that noise and emissions analyses can be performed with up-to-date information.

Massport first explored the use of AEDT for the *2015 EDR* and adopted AEDT as its ongoing noise model beginning with the 2016 EDR. In transitioning from INM to AEDT, Massport has investigated how to implement the historical adjustments in the new software. While the Massachusetts state EDR/ESPR process does not require FAA approval, Massport wishes to perform analysis to FAA standards. Massport has held numerous meetings with FAA since the release of AEDT to get approval for adjustments to AEDT. The set of formal request memoranda from Massport to FAA, and FAA's response, are presented later in this section. The following is a summary of the proposed measures to address the adjustments previously implemented in INM, and FAA's response.

- ***Altitude control codes***. This feature of AEDT performs a similar function to the custom profiles used previously, using altitude data to more accurately calculate aircraft thrust levels. Since this is a capability built into AEDT, **FAA approval is implicit** and was not requested.
- ***Aircraft weight adjustment***. It has been determined that aircraft takeoff weights, based on Department of Transportation T-100 data, do not always match the weight assumptions made by AEDT. Consequently, an adjustment has been made to more accurately represent takeoff weight, and therefore aircraft thrust during takeoff. **FAA concurs with this approach**.
- ***Annual weather***. AEDT by default uses 30-year average weather for the Airport. Massport has proposed using an annual average for the year under study to better capture year-to-year variations in weather.[14] **FAA concurs with this approach**.
- ***Hill effects***. Massport has proposed including the adjustments previously used in INM. **FAA does not concur with this approach**. There are ongoing research studies to develop modifications to the AEDT model and FAA recommends waiting until those methods are available.
- ***Over water adjustment***. Massport explored other options including the existing INM adjustment method. Massport proposed including the adjustments previously used in INM. **FAA does not concur with this approach**. There are ongoing research studies to develop modifications to the AEDT model and FAA recommends waiting until those methods are available.

Massport will continue to work with FAA to address these issues and to incorporate enhancements to AEDT as they become available. In March 2017, the Airport Cooperative Research Program (ACRP) published an FAA-sponsored study entitled "Improving AEDT Noise Modeling of Ground Surfaces." The study recommends a methodology and provides guidance for implementation in AEDT, however at the

13 AEDT 2A was released in 2013 and replaced the NIRS model for airspace analysis. AEDT 2B replaces, AEDT 2A, INM and EDMS.

14 Daily weather is currently not an option in AEDT modeling inputs, however Massport will continue to request that FAA allow for such an option.

time of this study, FAA has not recommended the method for use with AEDT or incorporated the ACRP study information into the AEDT.

In March 2018, ACRP published "Enhanced AEDT Modeling of Aircraft Arrival and Departure Profiles Volume 1: Guidance."[15] It highlights new data with alternate default profiles for specific aircraft and new methodology available to model users to customize flight profiles in greater detail than was previously available. The study recommends a methodology and provides guidance for implementation in AEDT, however at the time of this study, FAA has not recommended the method for use with AEDT or incorporated the ACRP study information into the AEDT.

At this time, FAA has concurred with adjustments for annual average weather and the adjustment of aircraft stage length, but disapproved adjustments for over-water effects and elevated terrain line-of-sight exposure. Massport has performed the AEDT analyses for 2016 and 2017 using only FAA-approved adjustments.

FAA's AEDT version 2c Service Pack 2 (AEDT 2c SP2) was released for general use on March 13, 2017; it was the version used to generate the 2016 DNL contours and accompanying noise analyses. AEDT version 2d was released on September 27, 2017; at the time of this reporting, it is the most current model version. Massport used AEDT 2d for the 2017 DNL contours and accompanying noise analyses.

The updates to AEDT 2d primarily focused on emissions data and reporting and not modifications to noise data or results. Three new aircraft types were added to AEDT 2d and are utilized in the *2017 ESPR* modeling; however, operations with these aircraft are small and differences between AEDT 2d and AEDT 2c SP2 with regard to noise are minimal.

The three new aircraft types are:

- Boeing 737-800 Max (7378MAX) – latest variant of the Boeing 737-800 aircraft with improved emissions and reduced noise levels;
- Global Express 6000 (BD-700-1A10) – Large Business Jet; and
- Global Express 5000 (BD-700-1A11) – Large Business Jet.

The following sections of this appendix provide several tables describing the AEDT input data for 2017. Where possible, the data for 2016 are included for comparison.

2017 Radar Data

Logan Airport's radar data provide the key to the RC for AEDT™ system. The Passive Surveillance Radar System (PASSUR) radar dataset was used for the *2004 ESPR* through the *2008 EDR*. For the *2009 EDR* through the *2014 EDR*, Massport used the radar data from its Harris NOMS system. These radar data are obtained from a multilateration system of eight sensors deployed around the Airport. The positioning data from these sensors are correlated to provide better, more accurate coverage of aircraft (in areas where the traditional FAA radar has limitations) and provide a more complete set of points to define each track. Traditional radar provides points every four to five seconds where the multilateration system provides data every second.

15 Airport Cooperative Research Program Web-Only Document 36: Enhanced AEDT Modeling of Aircraft Arrival and Departure Profiles, Volume 1: Guidance. http://www.trb.org/Main/Blurbs/178074.aspx.

In 2015, the Massport system switched to FAA's NextGen data feed, which integrates the Automatic Dependent Surveillance Broadcast (ADS-B) feed with multiple redundant real-time FAA surveillance sources into a single fused data feed. The NextGen data is a "multisensor based" subscription data source that aggregates all available surveillance sources, including:

- FAA En Route Radars;
- FAA Terminal Radars;
- FAA Airport Surface Detection Equipment X Band (ASDE-X) Systems;
- FAA Aircraft Situational Display to Industry (ASDI) Oceanic and Canadian Tracks only; and
- Harris ADS-B Data Feed.

Logan Airport is supported by an FAA ASDE-X system which provides highly accurate one-second data points for aircraft situational awareness on the Airport and within at least 5 miles of the Airport. These data are fused with the other sources and provided to the Massport NOMS system in a geo-referenced data format. The geo-referenced radar data are imported into the AEDT model, which is built on a geo-referenced platform to retain accuracy of the data for modeling.

The system was able to collect 365 complete days of data for 2017 with approximately 98 percent of these tracks (394,548 out of the total 404,139) usable for the development of the noise exposure contours.

Fleet Mix

The 2017 radar data were first processed to establish a baseline set of operations. After processing, the operations from these tracks were then scaled upwards by airline and aircraft type to match the reported totals provided by Massport for 2017. **Tables H-1a** (2017) and **H-1b** (2016 for comparison) provide the scaled annual operations, by Aircraft Noise and Performance (ANP) aircraft type. Each ANP type listed in **Tables H-1a** and **H-1b** is also mapped to a Runway Use group based on its weight and performance characteristics described in the Runway Use section below.

Regional jets (RJ) are defined as those aircraft with 90 or fewer seats, consistent with the categorization in Chapter 2, *Activity Levels*.[16] For years prior to 2010, the RJs in this report were classified as aircraft with less than 100 seats. When RJs first started gaining popularity, the aircraft types available were typically 50 seats or less with the traditional air carrier jet being 100 seats and higher. As newer aircraft types have become available, the smaller 35 to 50 seat types have been replaced by 70 to 99-seat types, with the 90 and above seat types flying many of the traditional air carrier routes. The majority of the newer types fall into two categories: the 70 to 75-seat category, which remain categorized as RJs, and the 91- to 99-seat category, which are categorized as air carrier jets. The Embraer 190 falls into this category and is now in the Light Jet B group.

16 U.S. Code, 2006 Edition, Supplement 3, Title 49 – Transportation Subtitle VII – Aviation Programs Part A – Air Commerce and Safety, Subpart II, Economic Regulation, Chapter 417 - Operations or Carriers, Subchapter III - Regional Air Service Incentive Program, Sec. 41762 – Definitions – defines RJ air carrier service to be aircraft with a maximum of 75 seats. Therefore, this report categorizes aircraft with 70-75 seats and below as RJ and aircraft with 90 seats and higher aircraft as air carrier (Note: there are no types with 75 to 90 seats).

Table H-1a 2017 Annual Modeled Operations

		Arrivals		Departures		
ANP Type	**Group**	**Day**	**Night**	**Day**	**Night**	**Total**
Commercial Jet Operations						
74720B	Heavy Jet A	2	2	2	1	6
747400	Heavy Jet A	428	18	375	71	891
7478	Heavy Jet A	343	0	341	2	686
A340-211	Heavy Jet A	189	4	107	87	387
A340-642	Heavy Jet A	97	1	81	17	197
A380-861	Heavy Jet A	90	0	88	2	179
767300	Heavy Jet B	1,619	627	1,496	750	4,493
767400	Heavy Jet B	14	3	12	5	34
767CF6	Heavy Jet B	29	11	8	32	80
767JT9	Heavy Jet B	52	13	2	63	130
777200	Heavy Jet B	1,024	182	1,105	101	2,412
777300	Heavy Jet B	16	1	8	9	34
7773ER	Heavy Jet B	841	160	228	773	2,002
7878R	Heavy Jet B	1,614	27	1,345	296	3,282
A300-622R	Heavy Jet B	374	639	572	441	2,025
A310-304	Heavy Jet B	436	47	244	239	966
A330-301	Heavy Jet B	2,463	12	2,094	381	4,949
A330-343	Heavy Jet B	1,565	13	751	827	3,157
DC1010	Heavy Jet B	168	97	199	66	531
DC1030	Heavy Jet B	16	7	15	8	46
MD11GE	Heavy Jet B	52	14	45	21	132
MD11PW	Heavy Jet B	23	4	21	6	54
717200	Light Jet A	2,282	468	2,151	598	5,499
MD9025	Light Jet A	476	25	490	11	1,002
MD9028	Light Jet A	238	12	246	4	501
737300	Light Jet B	1,193	432	1,349	275	3,250
737400	Light Jet B	14	9	9	15	47
737500	Light Jet B	0	2	0	2	4
737700	Light Jet B	6,696	2,064	7,339	1,421	17,520
737800	Light Jet B	18,826	6,821	20,999	4,649	51,295
7378MAX	Light Jet B	16	0	15	1	32
757300	Light Jet B	716	313	772	257	2,059
757PW	Light Jet B	1,303	505	1,258	547	3,612
757RR	Light Jet B	2,165	491	2,396	263	5,316
A319-131	Light Jet B	8,914	1,633	9,053	1,494	21,094
A320-211	Light Jet B	3,691	1,144	4,452	383	9,670
A320-232	Light Jet B	17,318	6,766	20,347	3,737	48,169
A321-232	Light Jet B	8,619	3,132	10,286	1,465	23,502
EMB190	Light Jet B	28,627	4,399	28,269	4,757	66,053
MD83	Light Jet B	503	72	534	42	1,151

Table H-1a 2017 Annual Modeled Operations (Continued)

		Arrivals		Departures		
ANP Type	**Group**	**Day**	**Night**	**Day**	**Night**	**Total**
Commercial Jet Operations, continued						
CL600	RJ	4,614	125	4,442	296	9,477
CRJ9-ER	RJ	6,024	548	5,842	730	13,144
EMB145	RJ	314	28	303	39	684
EMB14L	RJ	1,060	28	1,012	76	2,176
EMB170	RJ	1,588	167	1,615	140	3,509
EMB175	RJ	4,533	708	4,575	667	10,483
LEAR35	RJ	1	1	1	1	4
	Commercial Jets Subtotal	**131,184**	**31,779**	**136,894**	**26,069**	**325,926**
Commercial Non-Jet Operations						
BEC58P	Non-jet	16,256	361	16,557	61	33,235
DHC8	Non-jet	43	0	43	0	87
DHC830	Non-jet	3,400	158	3,323	236	7,117
PA42	Non-jet	190	3	193	0	386
SF340	Non-jet	1,719	0	1,719	0	3,438
	Commercial Non-Jet Operations Subtotal	**21,609**	**522**	**21,835**	**296**	**44,264**
	Commercial Aircraft Total	**152,793**	**32,302**	**158,729**	**26,366**	**370,190**
General Aviation Operations						
A109	Helicopter	17	1	17	1	36
B206L	Helicopter	2	0	2	0	4
B407	Helicopter	2	0	2	0	4
B429	Helicopter	4	0	4	0	8
B430	Helicopter	2	0	2	0	4
EC130	Helicopter	8	0	8	1	17
H500D	Helicopter	1	0	1	0	2
S76	Helicopter	116	11	107	20	254
SA330J	Helicopter	170	9	166	13	358
SA350D	Helicopter	3	0	3	0	6
SA355F	Helicopter	2	0	2	0	4
SA365N	Helicopter	2	0	2	0	4
747400	Heavy Jet A	0	1	0	1	2
747SP	Heavy Jet A	1	1	2	1	6
767300	Heavy Jet B	2	0	2	0	4
A330-301	Heavy Jet B	2	0	2	0	4
727EM1	Light Jet A	2	0	1	1	4
727EM2	Light Jet A	0	1	1	0	2
737400	Light Jet B	18	8	20	6	51

Table H-1a	2017 Annual Modeled Operations (Continued)					
		Arrivals		Departures		
ANP Type	Group	Day	Night	Day	Night	Total
General Aviation Operations, continued						
737700	Light Jet B	12	1	12	1	26
737N17	Light Jet B	0	1	0	1	2
757300	Light Jet B	1	0	0	1	2
757RR	Light Jet B	0	1	1	0	2
A319-131	Light Jet B	3	0	2	1	6
A320-211	Light Jet B	1	0	1	0	2
EMB190	Light Jet B	3	1	4	0	8
MD81	Light Jet B	1	2	0	3	6
1900D	Non-jet	4	0	4	0	8
BEC58P	Non-jet	705	44	703	46	1,498
CNA172	Non-jet	29	0	29	0	58
CNA182	Non-jet	71	1	71	1	143
CNA206	Non-jet	20	0	20	0	40
CNA208	Non-jet	1,272	267	1,441	98	3,078
CNA441	Non-jet	37	5	41	2	85
COMSEP	Non-jet	352	52	375	30	808
DHC6	Non-jet	856	97	854	98	1,905
DHC8	Non-jet	2	0	2	0	4
DO328	Non-jet	7	0	7	0	13
EMB120	Non-jet	2	0	2	0	4
GASEPF	Non-jet	21	0	21	0	41
GASEPV	Non-jet	208	6	205	9	428
PA28	Non-jet	23	0	23	0	45
PA30	Non-jet	7	1	8	0	15
PA42	Non-jet	25	0	24	2	51
SF340	Non-jet	770	2	767	5	1,545
BD-700-1A10	RJ	351	35	347	39	772
BD-700-1A11	RJ	97	14	103	8	220
CIT3	RJ	30	2	28	4	64
CL600	RJ	1,269	103	1,289	83	2,745
CL601	RJ	203	21	208	16	448
CNA500	RJ	138	17	146	10	311
CNA510	RJ	86	10	85	11	192
CNA525C	RJ	266	51	293	23	633
CNA55B	RJ	629	60	634	54	1,377
CNA560E	RJ	148	9	151	7	315
CNA560U	RJ	904	77	918	64	1,963
CNA560XL	RJ	202	13	202	13	430
CNA680	RJ	619	46	639	26	1,330
CNA750	RJ	1,465	148	1,493	119	3,225

Table H-1a 2017 Annual Modeled Operations (Continued)

		Arrivals		Departures		
ANP Type	**Group**	**Day**	**Night**	**Day**	**Night**	**Total**
General Aviation Operations, continued						
ECLIPSE500	RJ	40	0	39	1	79
EMB145	RJ	31	2	33	0	66
EMB14L	RJ	22	1	24	0	47
GIV	RJ	575	49	578	47	1,249
GV	RJ	491	73	519	45	1,128
IA1125	RJ	182	9	184	8	382
LEAR35	RJ	1,177	129	1,178	128	2,611
MU3001	RJ	473	27	470	30	1,000
General Aviation Total		**14,180**	**1,410**	**14,514**	**1,077**	**31,181**
Grand Total		**166,974**	**33,712**	**173,243**	**27,443**	**401,371**

Source: HMMH, 2018.
Notes: ANP - Aircraft Noise and Performance.
BEC58P is the AEDT substitution for the Cessna 402.
The CRJ9-ER in the RJ category is the CRJ700 aircraft.
Annual operations modeled in the 2017 annual contour.
Some totals may not match due to rounding.

Table H-1b 2016 Annual Modeled Operations

		Arrivals		Departures		
ANP Type	**Group**	**Day**	**Night**	**Day**	**Night**	**Total**
Commercial Jet Operations						
747400	HJA	877	19	491	405	1,792
7478	HJA	274	1	260	15	549
A340-211	HJA	125	0	51	75	250
A340-642	HJA	502	1	400	103	1,006
A380-841	HJA	1	1	2	0	4
A380-861	HJA	1	0	1	0	2
767300	HJB	1,051	582	979	653	3,264
767400	HJB	484	2	480	6	972
767CF6	HJB	70	1	67	3	141
767JT9	HJB	27	0	19	8	54
777200	HJB	775	123	789	109	1,797
777300	HJB	1	0	1	0	2
7773ER	HJB	962	102	452	611	2,127
7878R	HJB	1,224	33	1,141	117	2,515
A300-622R	HJB	188	478	328	338	1,331
A310-304	HJB	190	36	91	135	451
A330-301	HJB	2,354	27	1,654	728	4,764
A330-343	HJB	1,062	7	549	520	2,138
DC1010	HJB	256	188	268	175	886
DC1030	HJB	74	48	74	47	242
MD11GE	HJB	37	20	27	29	113
MD11PW	HJB	22	12	18	16	68
717200	LJA	2,798	413	2,866	345	6,421
727EM2	LJA	1	0	1	0	1
MD9025	LJA	1,064	161	1,064	161	2,450
MD9028	LJA	538	72	536	74	1,220
737300	LJB	1,792	324	1,829	287	4,234
7373B2	LJB	112	25	120	18	274
737400	LJB	11	5	8	8	32
737500	LJB	1	0	1	0	2
737700	LJB	7,262	2,260	7,908	1,613	19,042
737800	LJB	16,665	6,965	19,675	3,954	47,259
737N17	LJB	1	0	1	0	2
757300	LJB	815	436	1,008	242	2,501
757PW	LJB	1,516	547	1,583	480	4,125
757RR	LJB	2,353	481	2,411	423	5,668
A319-131	LJB	9,753	1,822	10,077	1,499	23,151
A320-211	LJB	3,879	900	4,417	362	9,557
A320-232	LJB	17,885	6,357	20,796	3,446	48,484
A321-232	LJB	5,299	1,552	5,750	1,101	13,702
EMB190	LJB	26,332	2,907	25,460	3,779	58,477

Table H-1b	2016 Annual Modeled Operations (Continued)					
		Arrivals		**Departures**		
ANP Type	**Group**	**Day**	**Night**	**Day**	**Night**	**Total**
Commercial Jet Operations, continued						
EMB195	LJB	1,608	124	1,549	183	3,464
MD82	LJB	6	0	6	0	12
MD83	LJB	827	135	810	152	1,924
CL601	RJ	5,418	167	5,153	432	11,170
CRJ9-ER	RJ	4,442	282	4,243	481	9,448
CRJ9-LR	RJ	1,446	61	1,390	118	3,014
EMB145	RJ	80	1	81	0	162
EMB14L	RJ	1,516	16	1,514	18	3,064
EMB170	RJ	1,691	218	1,750	159	3,818
EMB175	RJ	2,654	330	2,641	342	5,966
GV	RJ	13	1	12	1	27
LEAR35	RJ	34	11	36	9	89
	Commercial Jets Subtotal	**128,363**	**28,250**	**132,832**	**23,782**	**313,227**
Commercial Non-Jet Operations						
BEC58P	Non-Jet	17,559	438	17,787	210	35,994
CNA208	Non-Jet	198	0	198	0	396
CNA441	Non-Jet	4	0	2	2	8
DHC8	Non-Jet	427	4	415	16	861
DHC830	Non-Jet	2,980	146	2,850	275	6,251
SF340	Non-Jet	1,827	4	1,826	5	3,662
	Commercial Non-Jet Operations Subtotal	**22,995**	**592**	**23,078**	**509**	**47,173**
	Commercial Aircraft Total	**151,358**	**28,842**	**155,911**	**24,290**	**360,401**
General Aviation Operations						
A109	Helicopter	29	1	28	2	59
B206B3	Helicopter	35	5	29	11	80
B206L	Helicopter	23	3	20	7	53
B212	Helicopter	14	0	11	3	29
B222	Helicopter	2	1	1	2	6
B407	Helicopter	25	2	24	4	55
B427	Helicopter	2	0	2	0	4
B429	Helicopter	9	0	7	2	18
BO105	Helicopter	7	0	7	0	14
EC130	Helicopter	14	0	13	1	29
H500D	Helicopter	6	1	6	1	14
R44	Helicopter	13	2	15	0	31
S61	Helicopter	6	0	6	0	12
S70	Helicopter	16	3	17	2	39
S76	Helicopter	61	9	59	10	139

Table H-1b 2016 Annual Modeled Operations (Continued)

		Arrivals		Departures		
ANP Type	**Group**	**Day**	**Night**	**Day**	**Night**	**Total**
General Aviation Operations, continued						
SA330J	Helicopter	108	4	105	7	223
SA350D	Helicopter	6	1	5	2	14
SA355F	Helicopter	26	0	21	4	51
SC300C	Helicopter	4	1	5	0	10
A340-211	HJA	2	0	1	1	4
A340-642	HJA	2	1	1	2	6
777200	HJB	0	2	0	2	4
DC93LW	LJA	2	0	0	2	4
737400	LJB	13	7	12	7	39
737700	LJB	16	3	16	3	39
737800	LJB	1	1	2	0	4
737N17	LJB	1	0	1	0	2
757PW	LJB	3	2	3	2	10
757RR	LJB	9	0	7	2	18
A319-131	LJB	2	7	8	1	18
A320-211	LJB	0	2	0	2	4
A320-232	LJB	1	1	2	0	4
EMB190	LJB	2	0	1	1	4
MD81	LJB	2	2	1	2	6
MD83	LJB	5	6	8	2	21
1900D	Non-Jet	2	0	2	0	4
BEC58P	Non-Jet	512	28	511	29	1,079
CNA172	Non-Jet	90	2	89	2	182
CNA182	Non-Jet	68	0	66	1	135
CNA206	Non-Jet	82	0	81	1	164
CNA208	Non-Jet	1,952	205	2,076	81	4,313
CNA20T	Non-Jet	9	0	9	0	18
CNA441	Non-Jet	409	56	398	67	930
DHC6	Non-Jet	1	0	1	0	2
DO228	Non-Jet	618	41	621	38	1,317
DO328	Non-Jet	3	0	3	0	6
GASEPF	Non-Jet	5	0	5	0	10
GASEPV	Non-Jet	406	18	406	18	848
PA28	Non-Jet	50	0	50	0	100
PA31	Non-Jet	72	1	71	2	145
PA42	Non-Jet	0	2	2	0	4
SD330	Non-Jet	15	0	15	0	31
CIT3	RJ	40	2	39	3	84
CL600	RJ	1,219	93	1,224	88	2,624
CL601	RJ	1,094	106	1,140	59	2,398
CNA500	RJ	44	5	46	3	98

Table H-1b 2016 Annual Modeled Operations (Continued)

		Arrivals		Departures		
ANP Type	**Group**	**Day**	**Night**	**Day**	**Night**	**Total**
General Aviation Operations, continued						
CNA510	RJ	39	11	39	11	100
CNA525C	RJ	360	43	351	51	805
CNA55B	RJ	159	15	152	22	348
CNA560E	RJ	605	67	628	45	1,346
CNA560U	RJ	118	9	116	11	254
CNA560XL	RJ	890	74	914	49	1,927
CNA680	RJ	441	22	430	33	926
CNA750	RJ	497	54	523	28	1,102
ECLIPSE500	RJ	16	0	16	0	33
EMB145	RJ	37	4	39	2	82
EMB14L	RJ	1	0	0	1	2
F10062	RJ	489	48	490	46	1,073
GIV	RJ	605	50	584	71	1,309
GV	RJ	884	98	904	78	1,964
IA1125	RJ	101	5	103	3	213
LEAR35	RJ	1,197	135	1,221	110	2,662
MU3001	RJ	522	32	523	31	1,108
General Aviation Total		**14,118**	**1,292**	**14,337**	**1,074**	**30,821**
Grand Total		**165,477**	**30,133**	**170,248**	**25,364**	**391,222**

Source: HMMH, 2017.
Notes: ANP - Aircraft Noise and Performance.
Annual operations modeled in the 2016 Annual contour.
Some totals may not match due to rounding.

In the calculation of DNL, annual operations data are scaled to represent an average annual day by dividing by the 365 days in a year. To compare operations between years, it is simpler to look at category totals. **Table H-2** summarizes the numbers of average daily operations by categories of aircraft operating at Logan Airport from 1990 through 2017. Operations are summarized by operator category (commercial/GA), aircraft category, and day or night operation (night defined as 10:00 PM to 7:00 AM, consistent with the definition of DNL). GA operations were not included in the noise modeling prior to 1998 and commercial jet operations were not separated until 1999.

Table H-2 Modeled Daily Operations[1] by Commercial and General Aviation (GA) Aircraft – 1990 to 2017

		1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Commercial Aircraft											
Stage 2 Jets[2]	Day	312.40	N/A	228.89	203.34	189.40	156.90	132.40	108.46	84.93	83.30
	Night	19.99	N/A	13.13	7.44	10.10	5.50	4.79	7.75	5.92	6.66
	Total	**332.39**	N/A	**242.02**	**210.78**	**199.50**	**162.40**	**137.19**	**116.21**	**90.85**	**89.96**
Stage 3 Jets	Day	288.89	N/A	384.49	418.99	425.70	429.40	439.81	505.08	541.43	597.28
	Night	57.25	N/A	58.29	65.47	62.80	69.00	80.16	85.06	95.54	98.59
	Total	**346.14**	N/A	**442.78**	**484.46**	**488.50**	**498.40**	**519.97**	**590.14**	**636.97**	**695.87**
Air Carrier Jets	Day	N/A[3]	N/A	N/A[3]	N/A[3]	N/A[3]	N/A[3]	N/A[3]	N/A[3]	N/A[3]	569.18
	Night	N/A[3]	N/A	N/A[3]	N/A[3]	N/A[3]	N/A[3]	N/A[3]	N/A[3]	N/A[3]	96.21
	Total	**N/A[3]**	N/A	**N/A[3]**	**N/A[3]**	**N/A[3]**	**N/A[3]**	**N/A[3]**	**N/A[3]**	**N/A[3]**	**665.39**
Regional Jets[5]	Day	N/A[3]	N/A	N/A[3]	N/A[3]	N/A[3]	N/A[3]	N/A[3]	N/A[3]	N/A[3]	28.10
	Night	N/A[3]	N/A	N/A[3]	N/A[3]	N/A[3]	N/A[3]	N/A[3]	N/A[3]	N/A[3]	2.38
	Total	**N/A[3]**	N/A	**N/A[3]**	**N/A[3]**	**N/A[3]**	**N/A[3]**	**N/A[3]**	**N/A[3]**	**N/A[3]**	**30.48**
Non-jets	Day	444.41	N/A	411.84	598.16	541.97	526.85	505.31	514.7	552.56	448.82
	Night	11.72	N/A	69.32	46.84	13.59	11.14	13.73	27.27	21.86	16.63
	Total	**456.13**	N/A	**481.16**	**645.00**	**555.56**	**537.99**	**519.04**	**541.97**	**574.42**	**465.45**
Total Commercial Operations											
Operations	Day	1045.70	N/A	1,025.22	1,220.49	1,157.07	1,113.15	1,077.52	1,128.24	1,178.92	1,129.90
	Night	88.96	N/A	140.74	119.75	86.49	85.64	98.68	120.08	123.32	121.88
	Total	**1,134.66**	N/A	**1,165.96**	**1,340.24**	**1,243.56**	**1,198.79**	**1,176.20**	**1,248.32**	**1,302.24**	**1,251.78**
GA Aircraft											
Stage 2 Jets[2]	Day	N/A[4]	N/A	N/A[4]	N/A[4]	N/A[4]	N/A[4]	N/A[4]	N/A[4]	5.25	9.89
	Night	N/A[4]	N/A	N/A[4]	N/A[4]	N/A[4]	N/A[4]	N/A[4]	N/A[4]	0.40	0.74
	Total	**N/A[4]**	N/A	**N/A[4]**	**N/A[4]**	**N/A[4]**	**N/A[4]**	**N/A[4]**	**N/A[4]**	**5.65**	**10.63**
Stage 3 Jets	Day	N/A[4]	N/A	N/A[4]	N/A[4]	N/A[4]	N/A[4]	N/A[4]	N/A[4]	30.54	48.46
	Night	N/A[4]	N/A	N/A[4]	N/A[4]	N/A[4]	N/A[4]	N/A[4]	N/A[4]	4.21	6.55
	Total	**N/A[4]**	N/A	**N/A[4]**	**N/A[4]**	**N/A[4]**	**N/A[4]**	**N/A[4]**	**N/A[4]**	**34.75**	**55.01**
Non-jets	Day	N/A[4]	N/A	N/A[4]	N/A[4]	N/A[4]	N/A[4]	N/A[4]	N/A[4]	37.29	19.36
	Night	N/A[4]	N/A	N/A[4]	N/A[4]	N/A[4]	N/A[4]	N/A[4]	N/A[4]	16.28	18.89
	Total	**N/A[4]**	N/A	**N/A[4]**	**N/A[4]**	**N/A[4]**	**N/A[4]**	**N/A[4]**	**N/A[4]**	**53.57**	**38.25**
Total GA Operations											
Operations	Day	N/A[4]	N/A	N/A[4]	N/A[4]	N/A[4]	N/A[4]	N/A[4]	N/A[4]	73.08	77.71
	Night	N/A[4]	N/A	N/A[4]	N/A[4]	N/A[4]	N/A[4]	N/A[4]	N/A[4]	20.89	26.17
	Total	**N/A[4]**	N/A	**N/A[4]**	**N/A[4]**	**N/A[4]**	**N/A[4]**	**N/A[4]**	**N/A[4]**	**93.97**	**103.88**
Overall totals											
Total	Day	1,045.70	N/A	1,025.22	1,220.49	1,157.07	1,113.15	1,077.52	1,128.24	1,252.00	1,207.61
	Night	88.96	N/A	140.74	119.75	86.49	85.64	98.68	120.08	144.21	148.05
	Total[4]	**1,134.66**	N/A	**1,165.96**	**1,340.24**	**1,243.56**	**1,198.79**	**1,176.20**	**1,248.32**	**1,396.21**	**1,355.66**

Table H-2 Modeled Daily Operations[1] by Commercial and General Aviation (GA) Aircraft – 1990 to 2017 (Continued)

		2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Commercial Aircraft											
Stage 2 Jets[2]	Day	5.13	1.18	0.05	0.08	0.03	0.05	0.03	0.03	0.01	0.00
	Night	0.26	0.05	0.00	0.00	0.01	0.01	0.00	0.01	0.01	0.00
	Total	**5.39**	**1.23**	**0.05**	**0.08**	**0.05**	**0.06**	**0.03**	**0.04**	**0.02**	**0.00**
Stage 3 Jets	Day	727.09	756.24	740.75	717.85	772.39	765.76	767.55	748.13	699.39	667.45
	Night	103.66	109.77	97.04	92.69	113.24	113.66	114.81	118.29	114.30	103.05
	Total	**830.75**	**866.01**	**837.79**	**810.54**	**885.63**	**879.42**	**882.36**	**866.42**	**813.69**	**770.50**
Air Carrier Jets	Day	648.95	569.99	500.70	461.06	518.96	505.48	490.63	472.39	443.15	422.92
	Night	99.79	101.30	83.52	72.69	89.24	91.99	92.71	96.28	89.89	82.21
	Total	**748.74**	**671.29**	**584.22**	**533.75**	**608.20**	**597.47**	**583.34**	**568.66**	**533.04**	**505.14**
Regional Jets[5]	Day	78.14	186.25	240.05	256.80	253.43	260.34	276.95	275.77	256.24	244.53
	Night	3.87	8.47	13.52	19.99	24.00	21.68	22.11	22.03	24.40	20.84
	Total	**82.01**	**194.72**	**253.57**	**276.79**	**277.43**	**282.01**	**299.06**	**297.80**	**280.64**	**265.37**
Non-jets	Day	409.62	317.62	165.45	135.18	133.24	148.77	140.81	145.27	132.52	136.43
	Night	21.58	10.97	3.45	2.41	3.03	3.02	3.26	3.47	4.00	5.56
	Total	**431.20**	**328.58**	**168.89**	**137.59**	**136.28**	**151.79**	**144.07**	**148.73**	**136.52**	**141.99**
Total Commercial Operations											
Operations	Day	1,141.84	1,075.04	906.25	853.10	905.66	914.59	908.41	893.43	831.92	804.77
	Night	125.51	120.79	100.49	95.10	116.29	116.68	118.09	121.77	118.31	108.65
	Total	**1,267.35**	**1,195.82**	**1,006.73**	**948.20**	**1,021.95**	**1,031.27**	**1,026.51**	**1,015.19**	**950.23**	**913.42**
GA Aircraft											
Stage 2 Jets[2]	Day	7.29	5.15	3.65	2.84	0.94	2.29	1.90	1.24	0.36	0.09
	Night	0.64	0.50	0.41	0.26	0.14	0.25	0.17	0.19	0.03	0.01
	Total	**7.93**	**5.65**	**4.08**	**3.10**	**1.08**	**2.54**	**2.07**	**1.43**	**0.38**	**0.10**
Stage 3 Jets	Day	40.08	34.23	37.83	46.21	53.72	58.84	61.08	54.82	43.98	22.31
	Night	3.21	3.28	6.42	6.98	8.37	9.33	6.57	6.39	4.52	2.28
	Total	**43.29**	**37.51**	**44.25**	**53.19**	**62.09**	**68.16**	**67.65**	**61.21**	**48.49**	**23.59**
Non-jets	Day	34.57	37.31	17.36	17.81	16.95	14.00	15.05	11.98	15.13	8.19
	Night	1.83	1.92	4.45	4.40	5.20	4.75	1.39	3.61	1.08	0.74
	Total	**36.40**	**39.23**	**21.81**	**22.21**	**22.14**	**18.75**	**16.44**	**15.58**	**16.20**	**8.93**
Total GA Operations											
Operations	Day	81.94	76.68	58.84	66.88	71.60	75.12	78.03	68.04	59.46	30.46
	Night	5.68	5.71	11.29	11.64	13.71	14.33	8.13	10.19	5.62	3.08
	Total	**87.62**	**82.39**	**70.13**	**78.52**	**85.31**	**89.46**	**86.15**	**78.22**	**65.05**	**33.54**
Overall totals											
Total	Day	1,223.78	1,151.72	965.09	919.98	977.27	989.71	986.43	961.46	891.39	834.33
	Night	131.19	126.50	111.78	106.74	130.00	131.02	126.22	131.96	123.93	111.70
	Total[4]	**1,354.97**	**1,278.21**	**1,076.86**	**1,026.72**	**1,107.26**	**1,120.73**	**1,112.66**	**1,093.42**	**1,015.31**	**946.03**

Table H-2 Modeled Daily Operations[1] by Commercial and General Aviation (GA) Aircraft – 1990 to 2017 (Continued)

		2010	2011	2012	2013	2014	2015	2016[6]	2017	Change 2016 to 2017
Commercial Aircraft										
Stage 2 Jets[2]	Day	0.01	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00
	Night	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Total	**0.02**	**0.01**	**0.01**	**0.01**	**0.00**	**0.00**	**0.00**	**0.00**	0.00
Stage 3 Jets	Day	674.25	684.19	649.22	667.65	670	685.92	713.65	734.46	20.81
	Night	107.92	109.38	106.55	115.91	123.6	130.96	142.16	158.49	16.33
	Total	**782.17**	**793.57**	**755.77**	**783.56**	**793.61**	**816.88**	**855.81**	**892.95**	37.14
Air Carrier Jets	Day	521.64	571.03	530.76	546.27	556.59	585.55	620.45	636.04	15.59
	Night	93.98	99.17	98.68	107.17	115.84	126.36	134.93	148.75	13.82
	Totals	**615.62**	**670.2**	**629.44**	**653.44**	**672.43**	**711.92**	**755.38**	**784.79**	29.41
Regional Jets[5]	Day	152.61	113.16	118.46	121.38	113.41	100.36	93.20	98.42	5.22
	Night	13.94	10.21	7.87	8.74	7.77	4.6	7.23	9.74	2.51
	Total	**166.55**	**123.37**	**126.33**	**130.12**	**121.18**	**104.96**	**100.43**	**108.16**	7.72
Non-jets	Day	138.53	135.18	133.92	132.33	128.45	125.27	125.88	119.03	(6.85)
	Night	5.21	4.73	3.06	3.21	2.28	2.41	3.01	2.24	(0.76)
	Total	**143.74**	**139.91**	**136.98**	**135.54**	**130.73**	**127.68**	**128.89**	**121.27**	(7.62)
Total Commercial Operations										
Operations	Day	812.78	819.39	783.14	799.99	798.45	811.19	839.53	853.49	13.96
	Night	113.13	114.11	109.62	119.12	125.88	133.37	145.17	160.73	15.56
	Total	**925.91**	**933.5**	**892.76**	**919.12**	**924.33**	**944.56**	**984.70**	**1,014.22**	29.52
GA Aircraft										
Stage 2 Jets[2]	Day	0.27	0.08	0.25	0.31	0.00	0.28	0.00	0.00	0.00
	Night	0.04	0.00	0.04	0.02	0.00	0.02	0.00	0.00	0.00
	Total	**0.30**	**0.08**	**0.29**	**0.33**	**0.00**	**0.30**	**0.00**	**0.00**	0.00
Stage 3 Jets	Day	27.80	52.51	52.93	51.21	52.64	51.82	51.82	52.19	0.36
	Night	3.21	5.35	7.20	5.10	4.65	4.28	4.59	4.56	(0.03)
	Total	**31.01**	**57.87**	**60.13**	**56.31**	**57.29**	**56.10**	**56.41**	**56.75**	0.34
Non-jets	Day	8.19	18.18	15.16	13.06	13.95	19.31	25.92	26.43	0.50
	Night	0.72	1.29	1.29	1.15	1.13	1.46	1.87	2.25	0.38
	Total	**8.92**	**19.48**	**16.45**	**14.22**	**15.08**	**20.77**	**27.79**	**28.68**	0.88
Total GA Operations										
Operations	Day	36.26	70.78	68.35	64.58	66.59	71.40	77.75	78.61	0.87
	Night	3.97	6.65	8.52	6.28	5.78	5.77	6.46	6.81	0.35
	Total	**40.22**	**77.43**	**76.86**	**70.85**	**72.37**	**77.17**	**84.21**	**85.43**	1.22
Overall Totals										
Total	Day	849.03	890.16	851.49	864.57	865.05	882.59	917.28	932.10	14.82
	Night	117.10	120.76	118.13	125.40	131.66	139.14	151.63	167.54	15.92
	Total[4]	**966.13**	**1,010.92**	**969.61**	**989.97**	**996.70**	**1,021.73**	**1,068.91**	**1,099.65**	30.74

Source: Massport's Noise Monitoring System and Revenue Office numbers, HMMH 2018.

Notes: N/A - Not available. Data from 1991 not available. Sums may be off slightly due to rounding. Negative numbers shown in parentheses ( ).

1 Includes scheduled and unscheduled operations.

2 Stage 2 aircraft are no longer permitted, effective December 31, 2015.

3 Regional Jet (RJ) operations were not tracked separately prior to 1999.

4 Totals prior to 1998 do not include GA operations.

5 RJ prior to 2010 was a jet with 100 seats or less. RJ in 2010 is a jet with less than 80 seats.

6 Minor errors reported for 2016 data in *2016 EDR* have been corrected in this table.

Commercial Jet Aircraft by Part 36 Stage Category

As described in the Regulatory Framework section of this appendix, jet aircraft are classified into categories referred to as stages based on noise levels. The heavier the aircraft, the more noise it is permitted to make within limits. Aircraft are allowed to be recertificated to the higher standard when modifications are made to the aircraft engine or design. Because of the substantial differences in noise between Stage 2, recertificated Stage 3, Stage 3, Stage 4, and Stage 5 aircraft, Massport tracks operations by these separate categories to follow their trends. **Table H-3** shows the percentage of commercial jet operations by stage category from 1998 through 2017.

One of the most significant changes occurring after the economic downturn in 2001 was the almost immediate retirement of the re-certificated Stage 3 aircraft from airlines' fleets due to their high operating costs. This type of accelerated retirement was not as prevalent during the 2008 to 2009 economic downturn since the major airlines no longer operated these aircraft.

Table H-3 Percentage of Commercial Jet Operations by Part 36 Stage Category – 1998 to 2017

	Stage 5 Requirements[1]	Stage 4 Requirements[2]	Stage 3[3]	Recertificated Stage 3[4]	Stage 2 Greater than 75,000 lbs.	Total
1998	N/A	N/A	65.9%	21.7%	12.4%	100%
1999	N/A	N/A	70.0%	21.0%	9.0%	100%
2000	N/A	N/A	75.0%	24.0%	1.0%	100%
2001	N/A	N/A	86.3%	13.6%	0.1%	100%
2002	N/A	N/A	92.8%	7.2%	0.0%	100%
2003	N/A	N/A	95.8%	4.1%	0.0%	100%
2004	N/A	N/A	97.8%	2.2%	0.0%	100%
2005	N/A	N/A	98.0%	2.0%	0.0%	100%
2006	N/A	N/A	98.6%	1.4%	0.0%	100%
2007	N/A	N/A	98.9%	1.1%	0.0%	100%
2008	N/A	N/A	99.1%	0.9%	0.0%	100%
2009	N/A	87.8%	11.3%	0.9%	0.0%	100%
2010	N/A	93.2%	5.7%	1.1%	0.0%	100%
2011	N/A	95.5%	4.0%	0.5%	0.0%	100%
2012	N/A	95.8%	4.1%	0.1%	0.0%	100%
2013	N/A	97.4%	2.6%	0.0%	0.0%	100%
2014	N/A	97.4%	2.6%	0.0%	0.0%	100%
2015	N/A	96.7%	3.3%	0.0%	0.0%	100%
2016	17.8%	79.2%	3.0%	0.0%	0.0%	100%
2017	17.7%	79.8%	2.4%	0.0%	0.0%	100%

Source: Massport and Federal Aviation Administration (FAA) radar data, HMMH 2018.
Notes: N/A – not applicable.
1 This column includes operations by aircraft that would qualify as Stage 5 recertificated. Aircraft certificated after January 1, 2018 must meet Stage 5 standards. The percent of Logan Airport operations in aircraft meeting Stage 5 requirements was not determined prior to 2016.
2 Aircraft that meet Stage 4 requirements are aircraft that are either certificated Stage 4 or would qualify if recertificated. Certificated Stage 4 aircraft were not available until 2006 and the percent of Logan Airport operations in aircraft that meet Stage 4 requirements was not determined prior to 2009.
Values less than 0.1% appear as 0.0% due to rounding.
3 Certificated Stage 3 aircraft are originally manufactured meeting Stage 3 requirements under Federal Regulation Part 36. This column includes only operations by Certificated Stage 3 aircraft that do not meet higher certification standards.
4 Recertificated Stage 3 aircraft are aircraft originally manufactured as a certified Stage 1 or 2 aircraft under Federal Regulation Part 36, which either have been treated with hushkits or have been re-engineered to meet Stage 3 requirements.

Nighttime Operations

Massport tracks flights that operate in the defined nighttime period between the hours of 10:00 PM to 7:00 AM, when each flight is penalized 10 dB in calculations of DNL. **Table H-4** shows this nighttime activity by different groups of aircraft. Nighttime flights by commercial jet operators increased by 11.2 percent in 2017 over the previous year. This follows increases of 6.6 percent in 2014, 5.9 percent in 2015, and 8.9 percent in 2016. Commercial non-jet operations decreased by 25.6 percent in 2017, following a

decrease of 29 percent in 2014, and then increases of 5.7 percent in 2015, and 24.9 percent in 2016. GA traffic increased by 5.1 percent in 2017, following decreases of 8.0 percent in 2014, 0.2 percent in 2015, and an increase of 12.3 percent in 2016. Overall, nighttime operations at Logan Airport increased by 10.2 percent in 2017, after increasing 5.0 percent in 2014, 5.7 percent in 2015, and 9.3 percent in 2016. As in years past, the majority of 2017 nighttime operations (between 10:00 PM and 7:00 AM) occurred either before midnight or after 5:00 AM.

Table H-4 Modeled Nighttime Operations at Logan Airport – 1990 to 2017

	Commercial Jets	Commercial Non-Jets	General Aviation	Total
1990	77.24	11.72	N/A	88.96
1991	N/A	N/A	N/A	N/A
1992	71.42	69.32	N/A	140.74
1993	72.91	46.84	N/A	119.75
1994	72.90	13.59	N/A	86.49
1995	74.50	11.14	N/A	85.64
1996	84.95	13.73	N/A	98.68
1997	92.81	27.27	N/A	120.08
1998	101.46	21.86	20.89[1]	144.21
1999	105.25	16.63	26.17	148.05
2000	103.92	21.58	5.68	131.19
2001	109.82	10.97	5.71	126.50
2002	97.04	3.45	11.29	111.78
2003	92.69	2.41	11.64	106.74
2004	113.26	3.03	13.71	130.00
2005	113.67	3.02	14.33	131.02
2006	114.81	3.26	8.13	126.22
2007	118.30	3.47	10.19	131.96
2008	114.31	4.00	5.62	123.93
2009	103.05	5.56	3.08	111.70
2010	107.93	5.21	3.97	117.10
2011	109.38	4.73	6.65	120.76
2012	106.55	3.06	8.52	118.13
2013	115.91	3.21	6.28	125.40
2014	123.60	2.28	5.78	131.66
2015	130.96	2.41	5.77	139.14
2016[2]	142.16	3.01	6.48	151.63
2017	158.49	2.24	6.81	167.55
Change (2016 to 2017)	**16.33**	**-0.77**	**0.33**	**15.5**
Percent Change	**11.5%**	**-25.6%**	**5.1%**	**10.5%**

Source: Massport, HMMH, 2018.
Notes: GA – general aviation; N/A - not available.
1 Previously reported as N/A. 1998 was the first year GA operations were reported and included in the total nighttime operations.
2 Minor errors reported for 2016 data in *2016 EDR* have been corrected in this table.

Runway Use

Using radar data, RC for AEDT™ determines which runway was used, the specific aircraft type, and time classification (daytime or nighttime) for each flight. Massport compares annual runway use to previous years using a variety of summary tables with different perspectives.

The first summary of daytime and nighttime runway usages presented here is broken into six representative aircraft groups, listed below with example aircraft types from each group:

- Heavy Jet A – B747s, A340s, DC-8s;
- Heavy Jet B – B767s, B777s, A300s, A310s, A330s, DC-10s, L1011s, MD-11s;
- Light Jet A – B717s, B727s, DC-9s, F100s, MD-90s;
- Light Jet B – B737s, B757s, A319s, A320s, B-146s, MD-80s, E190;
- Regional Jet (RJ) – E135, E145, E170, CRJ2, CRJ7, CRJ9, J328 and Corporate Jets; and
- Turboprops and Piston Aircraft (non-jets).

Table H-5a shows the runway use summary from the modeled 2017 noise conditions. **Table H-5b** shows the corresponding summary from the modeled 2016 noise conditions. The turbojet aircraft in the table were grouped into different categories for reporting purposes. Because the DNL contours developed using RC for AEDT™ reflect the actual use of the runways by each flight, they accurately represent Logan Airport's noise environment. The modeled runway use for each particular aircraft type may be different from the overall group runway use presented in **Tables H-5a** and **H-5b**.

Comparing **Table H-5a** (2017) with the similar **Table H-5b** (2016) shows the largest changes were a 29-percent increase in the share of nighttime arrivals of the Heavy Jet A group on Runway 33L, and corresponding decreases in the same category of 19 percent and 8 percent to Runways 22L and 4R, respectively. All other categories also show less use of Runways 22L and 4R, in both arrival and departure operations (with the exception of Light Jet A daytime operations). Runway 4R-22L was closed for 35 days in 2017, which explains its decrease annual usage. Departures on Runway 33L showed increases in every category, as did arrivals to Runway 15R.

Table H-5a 2017 Modeled Runway Use by Aircraft Group

	Heavy Jet A		Heavy Jet B		Light Jet A		Light Jet B		Regional Jets		Non-Jets	
							ARRIVALS					
Runway	Day (%)	Night (%)	Day (%)	Night (%)	Day (%)	Night (%)	Day (%)	Night (%)	Day (%)	Night (%)	Day (%)	Night (%)
04L	1.47	0.00	2.33	1.49	3.56	1.85	4.66	1.65	8.90	2.26	16.96	4.03
04R	30.73	22.06	30.11	13.13	25.28	12.55	22.76	12.06	18.54	14.18	9.72	9.78
09	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
14	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
15L	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.18	0.29
15R	7.22	3.59	6.30	3.33	5.05	3.22	4.78	3.30	4.17	2.64	4.60	4.00
22L	24.67	24.39	22.88	27.48	23.82	25.74	22.27	24.73	23.09	27.40	25.32	27.22
22R	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.04	0.00	2.55	1.15
27	8.07	3.44	20.44	5.42	30.98	22.43	29.99	25.94	23.61	31.74	7.27	14.64
32	0.00	0.00	0.00	0.00	0.00	0.00	1.48	0.01	6.08	0.16	14.15	0.00
33L	27.84	46.52	17.94	49.16	11.31	34.21	14.06	32.31	15.58	21.63	9.82	30.42
33R	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	7.43	8.47
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
							DEPARTURES					
Runway	Day (%)	Night (%)	Day (%)	Night (%)	Day (%)	Night (%)	Day (%)	Night (%)	Day (%)	Night (%)	Day (%)	Night (%)
04L	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	15.17	6.42
04R	5.64	3.86	7.13	2.05	0.65	0.36	2.66	1.31	0.16	0.35	3.74	0.81
09	6.44	4.92	14.85	10.10	29.26	17.65	27.13	15.25	31.70	19.35	17.44	9.02
14	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.07	0.00
15L	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
15R	30.52	26.79	16.32	21.90	1.33	10.22	3.25	14.61	0.40	9.29	1.51	20.17
22L	6.25	0.84	4.37	1.09	0.26	0.36	1.39	0.62	0.03	0.11	0.03	0.16
22R	17.15	16.44	23.02	21.32	30.93	25.66	28.77	19.97	31.84	26.24	30.73	22.78
27	1.90	0.00	7.42	1.54	17.81	35.64	13.04	28.26	14.62	28.33	6.95	5.51
32	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
33L	32.10	47.15	26.91	41.99	19.75	10.11	23.76	19.98	21.25	16.35	24.37	35.14
33R	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

Source: Massport, HMMH, 2018.
Notes: Night for noise modeling is defined as 10:00 PM to 7:00 AM.
Values may not add to 100 percent due to rounding.

Table H-5b 2016 Modeled Runway Use by Aircraft Group

	Heavy Jet A		Heavy Jet B		Light Jet A		Light Jet B		Regional Jets		Non-Jets	
ARRIVALS												
Runway	**Day (%)**	**Night (%)**	**Day (%)**	**Night (%)**	**Day (%)**	**Night (%)**	**Day (%)**	**Night (%)**	**Day (%)**	**Night (%)**	**Day (%)**	**Night (%)**
04L	0.06	0.00	0.09	0.00	3.31	0.15	3.15	0.15	10.31	0.67	21.94	1.16
04R	42.33	30.39	39.39	22.67	34.49	19.77	34.35	20.51	27.01	23.83	16.74	21.14
09	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
14	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
15L	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.19	0.00
15R	0.95	0.00	0.89	0.96	0.62	1.10	0.80	0.55	0.59	0.74	0.50	0.18
22L	31.07	43.55	25.75	27.69	20.99	30.81	22.67	30.33	23.51	32.15	26.39	37.01
22R	0.00	0.00	0.00	0.00	0.02	0.00	0.01	0.00	0.02	0.00	3.03	3.12
27	5.46	8.68	18.07	3.97	27.61	28.16	25.91	19.35	19.68	20.03	5.14	10.61
32	0.00	0.00	0.00	0.00	0.00	0.00	1.13	0.00	5.25	0.00	11.97	0.00
33L	20.13	17.37	15.80	44.70	12.96	20.00	11.99	29.11	13.63	22.58	7.77	20.63
33R	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	6.32	6.15
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
DEPARTURES												
Runway	**Day (%)**	**Night (%)**	**Day (%)**	**Night (%)**	**Day (%)**	**Night (%)**	**Day (%)**	**Night (%)**	**Day (%)**	**Night (%)**	**Day (%)**	**Night (%)**
04L	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	18.85	11.48
04R	9.16	6.87	10.78	4.05	0.65	1.92	4.94	3.61	0.58	0.71	4.60	4.85
09	8.67	6.70	16.72	11.23	37.90	25.24	31.28	20.45	37.50	25.94	19.94	8.58
14	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.00
15L	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
15R	31.30	33.68	15.41	25.89	2.30	8.66	3.99	15.82	2.25	14.83	2.28	12.62
22L	7.82	3.02	6.57	2.53	0.29	1.04	2.48	2.42	0.17	0.55	0.35	0.54
22R	17.75	18.08	21.50	19.38	29.18	29.58	27.25	22.31	29.80	26.17	29.67	34.91
27	0.58	0.33	6.21	0.94	14.94	29.55	11.73	22.52	12.60	20.82	5.32	7.32
32	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.05	0.14
33L	24.72	31.32	22.80	35.99	14.75	4.01	18.33	12.87	17.09	10.97	18.82	19.56
33R	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.09	0.00
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

Source: Massport, HMMH, 2017.
Notes: Nighttime for noise modeling is defined as 10:00 PM to 7:00 AM.
Values may not add to 100 percent due to rounding.

While **Tables H-5a** and **H-5b** present runway use by aircraft groups, **Tables H-6a** and **H-6b** present the total runway use (jets and non-jets) by runway and time of day. The first section of the table displays the number of operations on each runway by time period for an average day. The second section displays the same information for the entire year and the last section displays the percent that each runway is used for a given operation type and time of day. **Table H-6a** shows that on an average day in 2017 Runway 22R had the most departures (154.7 per day and night combined) and Runway 27 had the most arrivals (135.6 per day and night combined). Considering just the nighttime period, Runways 27 and 33L each had over 17 departures, on average, per night, while Runway 33L had the most arrivals (30 per night). In comparison, **Table H-6b** shows that on an average day in 2016, Runway 9 had the most departures (151.7 per day and night combined) and Runway 4R had the most arrivals (155.2 per day and night combined). At night, Runway 22R had the most departures (15.7 per night) but Runway 22L had the most arrivals (25.1 per night).

Table H-6a Summary of Jet and Non-Jet Aircraft Runway Use: 2017

	Runway												
	4L	**4R**	**9**	**14**	**15L**	**15R**	**22L**	**22R**	**27**	**32**	**33L**	**33R**	**Total**
2017 Daily Operations													
Dep Day	11.1	12.4	122.0	0.1	0.0	15.5	5.3	138.9	57.6	0.0	111.8	0.0	474.6
Dep Night	0.1	1.0	11.1	0.0	0.0	11.5	0.5	15.8	17.9	0.0	17.4	0.0	75.2
Arr Day	32.5	94.1	0.0	0.0	1.6	21.8	105.1	1.9	112.7	18.8	63.6	5.4	457.5
Arr Night	1.6	11.3	0.0	0.0	0.0	3.0	23.3	0.0	22.9	0.0	30.0	0.2	92.4
Total Daily Operations	45.4	118.8	133.1	0.1	1.6	51.8	134.1	156.6	211.1	18.8	222.8	5.6	1,099.6
2017 Annual Operations													
Dep Day	4,058	4,524	44,529	19	0	5,653	1,922	50,703	21,012	0	40,822	0	173,243
Dep Night	40	357	4,051	0	0	4,181	170	5,761	6,550	0	6,333	0	27,443
Arr Day	11,867	34,355	0	0	575	7,957	38,366	689	41,130	6,848	23,229	1,957	166,974
Arr Night	595	4,122	0	0	3	1,103	8,488	12	8,357	7	10,939	86	33,712
Total Annual Operations	16,560	43,358	48,580	19	578	18,895	48,947	57,164	77,050	6,855	81,323	2,043	401,371
2017 Percentage Operations													
Dep Day	2%	3%	26%	<1%	0%	3%	1%	29%	12%	0%	24%	0%	100%
Dep Night	<1%	1%	15%	0%	0%	15%	1%	21%	24%	0%	23%	0%	100%
Arr Day	7%	21%	0%	0%	<1%	5%	23%	<1%	25%	4%	14%	1%	100%
Arr Night	2%	12%	0%	0%	<1%	3%	25%	<1%	25%	<1%	32%	<1%	100%

Source: Massport Noise Office and HMMH 2018.

Notes: These data reflect actual counts or percentages of aircraft operations on each runway end. They should not be confused with effective runway use, which is used by the Preferential Runway Advisory System (PRAS) to derive recommendations for use of a particular runway.

Runway 14-32 is unidirectional: there are no arrivals to Runway 14 and no departures from Runway 32.

Values may not add to 100 percent due to rounding.

Table H-6b Summary of Jet and Non-Jet Aircraft Runway Use: 2016

	Runway												
	4L	**4R**	**9**	**14**	**15L**	**15R**	**22L**	**22R**	**27**	**32**	**33L**	**33R**	**Total**
2016 Daily Operations													
Dep Day	14.2	20.3	138.4	0.0	0.0	18.8	8.9	129.0	49.2	0.0	85.2	0.1	464.1
Dep Night	0.2	2.4	13.2	0.0	0.0	12.0	1.5	15.7	12.8	0.0	11.3	0.0	69.1
Arr Day	32.6	138.1	0.0	0.0	0.1	3.2	106.6	2.3	94.2	15.7	53.5	4.7	451.0
Arr Night	0.2	17.2	0.0	0.0	0.0	0.5	25.1	0.1	15.2	0.0	23.9	0.2	82.2
Total Daily Operations	47.1	177.9	151.7	0.0	0.1	34.5	142.1	147.0	171.4	15.8	173.9	4.9	1,066.5
2016 Annual Operations													
Dep Day	5,179	7,413	50,669	8	0	6,897	3,268	47,196	18,019	14	31,175	25	169,865
Dep Night	86	880	4,836	0	0	4,375	555	5,743	4,699	1	4,130	0	25,305
Arr Day	11,921	50,529	0	0	53	1,185	39,010	837	34,462	5,752	19,597	1,723	165,069
Arr Night	62	6,278	0	0	0	176	9,191	30	5,555	0	8,750	58	30,100
Total Annual Operations	17,247	65,101	55,505	8	53	12,633	52,024	53,806	62,736	5,768	63,653	1,806	390,339
2016 Percentage Operations													
Dep Day	3%	4%	30%	<1%	0%	4%	2%	28%	11%	<1%	18%	<1%	100%
Dep Night	<1%	3%	19%	0%	0%	17%	2%	23%	19%	<1%	16%	0%	100%
Arr Day	7%	31%	0%	0%	<1%	1%	24%	1%	21%	3%	12%	1%	100%
Arr Night	<1%	21%	0%	0%	0%	1%	31%	<1%	18%	0%	29%	<1%	100%

Source: Massport Noise Office and HMMH 2017.

Notes: These data reflect actual counts or percentages of aircraft operations on each runway end. They should not be confused with effective runway use, which is used by the Preferential Runway Advisory System (PRAS) to derive recommendations for use of a particular runway.
Runway 14-32 is unidirectional: there are no arrivals to Runway 14 and no departures from Runway 32.
Values may not add to 100 percent due to rounding.

Runway use can also be presented in terms of percent of total operations. **Table H-7** presents the 2017 and 2016 runway use for all operations which use Logan Airport, supplementing the information in **Tables H-5a** and **H-5b** that separate runway use by aircraft group and time of day, and the data in **Tables H-6a** and **H-6b** which total the runway use by operation type and time of day.

In 2017, Runway 33L was the runway with the highest activity (a mix of jet arrivals and departures) with Runway 27 a very close second. For 2016, Runway 4R was the most active, with primarily jet arrivals, followed by Runway 33L and Runway 27, each with a mix of arrivals and departures. Non-jets use Runways 4L and 22L most for arrivals, and Runway 22R most for departures.

Table H-7 Total 2017 and 2016 Modeled Runway Use by All Operations

	Jet Arrivals		Non-Jet Arrivals		Jet Departures		Non-Jet Departures		All Operations
	Day	Night	Day	Night	Day	Night	Day	Night	
Runway	**2017 Operations**								
4L	1.8%	0.1%	1.1%	<0.1%	0.0%	0.0%	1.0%	<0.1%	4.1%
4R	7.9%	1.0%	0.6%	<0.1%	0.9%	0.1%	0.2%	<0.1%	10.8%
9	0.0%	0.0%	0.0%	0.0%	9.9%	1.0%	1.2%	<0.1%	12.1%
14	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	<0.1%	0.0%	<0.1%
15L	0.0%	0.0%	0.1%	<0.1%	0.0%	0.0%	0.0%	0.0%	0.1%
15R	1.7%	0.3%	0.3%	<0.1%	1.3%	1.0%	0.1%	<0.1%	4.7%
22L	7.9%	2.0%	1.7%	0.1%	0.5%	<0.1%	<0.1%	<0.1%	12.2%
22R	<0.1%	0.0%	0.2%	<0.1%	10.6%	1.4%	2.0%	<0.1%	14.2%
27	9.8%	2.0%	0.5%	<0.1%	4.8%	1.6%	0.5%	<0.1%	19.2%
32	0.8%	<0.1%	0.9%	0.0%	0.0%	0.0%	0.0%	0.0%	1.7%
33L	5.1%	2.6%	0.6%	0.1%	8.5%	1.5%	1.6%	0.1%	20.3%
33R	0.0%	0.0%	0.5%	<0.1%	0.0%	0.0%	0.0%	0.0%	0.5%
Total	35.0%	8.1%	6.6%	0.3%	36.5%	6.7%	6.7%	0.2%	100.0%
	Jet Arrivals		**Non-Jet Arrivals**		**Jet Departures**		**Non-Jet Departures**		**All Operations**
	Day	**Night**	**Day**	**Night**	**Day**	**Night**	**Day**	**Night**	
Runway	**2016 Operations**								
4L	1.5%	<0.1%	1.5%	<0.1%	0.0%	0.0%	1.3%	<0.1%	4.4%
4R	11.8%	1.6%	1.2%	0.1%	1.6%	0.2%	0.3%	<0.1%	16.7%
9	0.0%	0.0%	0.0%	0.0%	11.6%	1.2%	1.4%	<0.1%	14.2%
14	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	<0.1%	0.0%	<0.1%
15L	0.0%	0.0%	<0.1%	0.0%	0.0%	0.0%	0.0%	0.0%	<0.1%
15R	0.3%	<0.1%	<0.1%	<0.1%	1.6%	1.1%	0.2%	<0.1%	3.2%
22L	8.1%	2.3%	1.8%	0.1%	0.8%	0.1%	<0.1%	<0.1%	13.3%
22R	<0.1%	0.0%	0.2%	<0.1%	10.0%	1.4%	2.1%	0.1%	13.8%
27	8.5%	1.4%	0.4%	<0.1%	4.2%	1.2%	0.4%	<0.1%	16.1%
32	0.6%	0.0%	0.8%	0.0%	0.0%	0.0%	<0.1%	<0.1%	1.5%
33L	4.5%	2.2%	0.5%	<0.1%	6.7%	1.0%	1.3%	<0.1%	16.3%
33R	0.0%	0.0%	0.4%	<0.1%	0.0%	0.0%	<0.1%	0.0%	<0.1%
Total	35.3%	7.5%	7.0%	0.2%	36.5%	6.3%	7.0%	0.2%	100.0%

Source: Massport, HMMH, 2018.
Notes: Night for noise modeling is defined as 10:00 PM to 7:00 AM.
Nighttime runway restrictions are from 11:00 PM to 6:00 AM.
Some percentages less than 0.5 percent for 2016 were reported as <0.1 percent; correct values shown here.
Values may not add to 100 percent due to rounding.

Table H-8 presents a historical summary of runway use by jets. Since 2009, the radar data have been analyzed with Massport's Harris NOMS. Data from 2001 through 2008 were compiled with Massport's PreFlight™ software, an analysis package used to access fleet, day/night splits, and runway use information from radar data. Data prior to 2001 were derived from Massport's original noise monitoring system, supplemented with field records. Note that Logan Airport Noise Rules prevent arrivals to Runway 22R and departures from Runway 4L by jet aircraft.

Table H-8 Summary of Jet Aircraft Runway Use – 1990 to 2017

Runway	4L	4R	9	14[1]	15R	22L	22R	27	32[1]	33L
1990										
Departures	0%[2]	3%	21%	N/A	10%	2%	36%	20%	N/A	7%
Arrivals	1%	25%	0%	N/A	2%	14%	0%	28%	N/A	29%
1992[2]										
Departures	0%	6%	31%	N/A	7%	2%	38%	10%	N/A	6%
Arrivals	1%	37%	0%	N/A	3%	12%	0%	30%	N/A	17%
1993										
Departures	0%	9%	33%	N/A	7%	3%	40%	4%	N/A	4%
Arrivals	2%	44%	0%	N/A	1%	11%	0%	28%	N/A	15%
1994										
Departures	0%	9%	33%	N/A	4%	3%	32%	12%	N/A	5%
Arrivals	3%	42%	0%	N/A	1%	8%	0%	27%	N/A	19%
1995										
Departures	0%	8%	36%	N/A	5%	5%	29%	11%	N/A	5%
Arrivals	3%	41%	0%	N/A	2%	8%	0%	27%	N/A	17%
1996										
Departures	0%	8%	32%	N/A	5%	6%	33%	12%	N/A	5%
Arrivals	2%	38%	0%	N/A	2%	11%	0%	29%	N/A	18%
1997										
Departures	0%	8%	30%	N/A	5%	6%	31%	15%	N/A	5%
Arrivals	2%	36%	0%	N/A	2%	9%	0%	30%	N/A	20%
1998										
Departures	0%	8%	35%	N/A	6%	5%	28%	14%	N/A	5%
Arrivals	2%	41%	0%	N/A	2%	7%	0%	28%	N/A	19%
1999										
Departures	0%	8%	31%	N/A	5%	4%	30%	15%	N/A	6%
Arrivals	3%	37%	0%	N/A	2%	10%	0%	28%	N/A	21%
2000										
Departures	0%	8%	35%	N/A	4%	3%	30%	15%	N/A	6%
Arrivals	4%	40%	0%	N/A	1%	7%	0%	28%	N/A	20%

Table H-8 Summary of Jet Aircraft Runway Use – 1990 to 2017 (Continued)

Runway	4L	4R	9	14[1]	15R	22L	22R	27	32[1]	33L
2001										
Departures	0%	7%	34%	N/A	4%	3%	35%	12%	N/A	5%
Arrivals	5%	36%	0%	N/A	1%	8%	0%	32%	N/A	18%
2002										
Departures	0%	4%	31%	N/A	6%	3%	35%	16%	N/A	6%
Arrivals	6%	31%	0%	N/A	1%	12%	0%	30%	N/A	21%
2003										
Departures	0%	4%	33%	N/A	7%	2%	34%	14%	N/A	6%
Arrivals	7%	33%	0%	N/A	1%	14%	0%	28%	N/A	18%
2004										
Departures	0%	5%	34%	N/A	10%	4%	24%	18%	N/A	6%
Arrivals	6%	34%	0%	N/A	1%	12%	0%	24%	N/A	23%
2005										
Departures	0%	5%	36%	N/A	7%	1%	31%	13%	N/A	7%
Arrivals	8%	33%	0%	N/A	1%	11%	0%	29%	N/A	17%
2006										
Departures	0%	4%	33%	0%	3%	1%	40%	13%	0%	6%
Arrivals	7%	29%	0%	0%	1%	14%	0%	33%	0.2%	16%
2007										
Departures	0%	5%	31%	0%	4%	1%	33%	7%	0%	19%
Arrivals	5%	31%	0%	0%	1%	15%	0%	36%	2%	11%
2008										
Departures	0%	6%	33%	<1%	3%	<1%	36%	6%	0%	16%
Arrivals	6%	30%	0%	0%	2%	17%	0%	33%	2%	11%
2009[3]										
Departures	0%	7%	32%	0%	3%	2%	34%	6%	0%	16%
Arrivals	7%	31%	0%	0%	3%	17%	0%	30%	1%	11%
2010										
Departures	0%	4%	28%	<1%	8%	2%	31%	10%	0%	17%
Arrivals	5%	28%	0%	0%	1%	15%	0%	32%	1%	16%
2011[4]										
Departures	0%	6%	36%	<1%	5%	2%	36%	7%	0%	7%
Arrivals	7%	37%	0%	0%	<1%	16%	0%	28%	1%	11%
2012[4]										
Departures	0%	6%	33%	<1%	5%	3%	38%	6%	0%	9%
Arrivals	6%	34%	0%	0%	1%	16%	0%	33%	<1%	9%
2013										
Departures	<1%	5%	30%	<1%	5%	2%	35%	12%	0%	12%
Arrivals	6%	29%	0%	0%	1%	16%	<1%	32%	1%	15%

Table H-8 Summary of Jet Aircraft Runway Use – 1990 to 2017 (Continued)

Runway	4L	4R	9	14[1]	15R	22L	22R	27	32[1]	33L
2014										
Departures	0%	5%	31%	<1%	5%	2%	28%	13%	0%	17%
Arrivals	5%	30%	0%	0%	2%	25%	<1%	21%	1%	16%
2015										
Departures	0%	4%	29%	<1%	5%	2%	32%	12%	0%	15%
Arrivals	5%	29%	0%	0%	2%	25%	<1%	23%	1%	16%
2016[5]										
Departures	0%	4%	30%	0%	6%	2%	27%	13%	0%	18%
Arrivals	4%	31%	0%	0%	1%	24%	<1%	23%	1%	16%
2017[6]										
Departures	0%	2%	25%	0%	5%	1%	28%	15%	0%	23%
Arrivals	5%	21%	0%	0%	5%	23%	<1%	27%	2%	18%

Source: HMMH 2018, Massport Noise Office.

Notes: These data reflect actual percentages of jet aircraft operations on each runway end. They should not be confused with effective runway use, which is used by the Preferential Runway Advisory System (PRAS) to derive recommendations for use of a particular runway. Effective runway percentages include a factor of 10 applied to nighttime operations so that use of a runway at night more closely reflects its effect on total noise exposure.

Jet aircraft are not able to use Runway 15L or 33R due to its length of only 2,557 feet.

Values may not add to 100 percent due to rounding.

N/A - not available.

1 Runway 14-32 opened in late November 2006. (Runway 14-32 is unidirectional with no arrivals to Runway 14 and no departures from Runway 32.)

2 The *1990 Final Generic Environmental Impact Report* was published and submitted to the Secretary of Environmental Affairs in July 1993. It included modeled operations and resulting noise contours for 1987, 1990, and a 1996-forecast year. The *1993 Annual Update* published in July 1994 included operations and contours for 1992 and 1993. 1991 data are not available.

3 Runway 9-27 had extended weekend closings for resurfacing during 2009.

4 Runway 15R-33L was closed for 3 months in 2011 and in 2012.

5 Runway 4L-22Rwas closed for 31 days in 2016.

6 Runway 4R-22L was closed for 35 days in 2017, with limited availability for Runway 4R arrivals for about 80 additional days.

Since runway use plays such a key role in determining noise the aircraft noise distribution in the Airport's environment, Massport also tracks the level of traffic off each runway end by combining counts of operations that overfly the same general area. The total operations and percentages shown for 2016 and 2017 in **Table H-9** represent the amount of activity experienced off each runway end for a given year.

Table H-9 Runway Usage by Runway End

		2016		2017	
Runway End	**Operation(s)[1]**	**Total Flights**	**% of Total[3]**	**Total Flights**	**% of Total[3]**
04L	R4L A + R22R D	64,921	**16.6%**	68,925	**17.2%**
04R	R4R A + R22L D	60,630	**15.5%**	40,570	**10.1%**
09	R9 A + R27 D	22,719	**5.8%**	27,562	**6.9%**
14	N/A	15	**0.0%**	0	**0.0%**
15L	R15L A + R33R D	78	**0.0%**	578	**0.1%**
15R	R15R A + R33L D	36,667	**9.4%**	55,867	**13.9%**
22L	R22L A + R4R D	56,495	**14.5%**	51,735	**12.9%**
22R	R22R A + R4L D	6,132	**1.6%**	4,799	**1.2%**
27	R27 A + R9 D	95,522	**24.5%**	98,068	**24.5%**
32	R32 A + R14 D	5,760	**1.5%**	6,874	**1.7%**
33L	R33L A + R15R D	39,619	**10.1%**	43,652	**10.9%**
33R	R33R A + R15L D	1,782	**0.5%**	2,043	**0.5%**
All[2]		**390,339**	**100.0%**	**400,672**	**100.0%**

Notes: N/A – not applicable.
Runway 14-32 is unidirectional: there are no arrivals to Runway 14 and no departures from Runway 32. The 15 operations shown in this row for 2016 are non-jet departures which were most likely erroneously associated with Runway 32 by the computer algorithm.

1 A=Arrivals; D=Departures.
2 Helicopter operations not included.
3 Percents are rounded to the nearest tenth.

Flight Tracks

RC for AEDT™ converts each radar track to an AEDT model track and then models the scaled aircraft operation on that track. This method keeps the modeled lateral and vertical dispersion of the aircraft types consistent with the radar data and ensures that anomalies in the departure paths are captured in the RC for AEDT™ system. **Table H-10** lists the number of flight tracks used in the RC for AEDT™ modeling system for 2017 and 2016. A sample of flight tracks from 2017 are displayed in **Figures 6-3** through **6-9** in Chapter 6, *Noise Abatement*.

Table H-10 Total Count of Flight Tracks Modeled in RC for AEDT™ (2017 and 2016)

	Runway											
	4L	**4R**	**9**	**14**	**15L**	**15R**	**22L**	**22R**	**27**	**32**	**33L**	**33R**
2017												
Departures	4,098	4,881	48,580	19	0	9,484	2,093	56,463	27,562	0	47,155	0
Arrivals	12,462	38,477	0	0	578	8,711	46,854	701	49,488	6,855	34,167	2,043
2016												
Departures	5,265	8,294	55,505	8	0	11,272	3,823	52,939	22,719	15	35,305	25
Arrivals	11,982	56,807	0	0	53	1,362	48,201	867	40,017	5,752	28,347	1,782

Source: HMMH, 2017/2018; Harris Noise and Operational Monitoring System (NOMS) data.

Annual Model Results and Status of Mitigation Programs

Noise Exposed Population

Table H-11 presents the noise-exposed population by community through 2017. This table includes population within the DNL 60 to 65 dB contours, although a DNL of 65 dB is the federally-defined noise criterion used as a guideline to identify when residential land use is considered incompatible with aircraft noise.

Table H-11 Noise-Exposed Population by Community

Year	Census Data	80+ dB	75+ dB	70-75 dB DNL	65-70 dB DNL[1]	Total (65+)	60-65 dB DNL
BOSTON[2]							
1990	1980	0	0	1,778	28,970	30,748	N/A
1992	1980	0	0	800	4,316	5,116	N/A
1993	1980	0	0	264	2,820	3,084	N/A
1994	1990	0	106	265	7,698	8,069	30,895
1995	1990	0	106	851	8,815	9,772	33,765
1996	1990	0	106	374	8,775	9,255	40,992
1997	1990	0	106	719	13,857	14,682	54,804
1998	1990	0	58	580	10,877	11,515	52,201
1999 [3]	1990	0	58	364	11,632	12,054	45,948
2000	2000	0	0	234	9,014	9,248	35,785
2001	2000	0	0	315	6,515	6,700	27,778
2002	2000	0	0	132	2,625	2,757	23,225
2003	2000	0	0	164	1,730	1,894	21,763
2004 [4]	2000	0	65	192	4,142	4,399	24,473
2005 [4]	2000	0	65	104	2,020	2,189	17,661
2006 [4]	2000	0	65	99	1,054	1,218	14,866
2007 [4,5]	2000	0	0	169	4,094	4,263	21,446
2008 [4,5]	2000	0	5	0	3,487	3,492	18,890
2009 [4,5]	2000	0	5	67	937	1,009	12,284
2010 [4,5]	2010	0	0	0	689	689	17,646
2011 [4,5]	2010	0	0	0	331	331	11,600
2012 [4,5]	2010	0	0	0	421	421	11,037
2013 [4,5]	2010	0	0	0	612	612	14,835
2014 [4,5]	2010	0	0	34	4,151	4,185	23,343
2015 [4,5]	2010	0	0	110	7,225	7,365	32,309
2016 [4,5]	2010	0	0	0	4,031	4,031	20,806
2017 [4,5]	2010	0	0	14	4,720	4,734	24,595
CHELSEA							
1990	1980	0	0	0	4,813	4,813	N/A
1992	1980	0	0	0	3,952	3,952	N/A
1993	1980	0	0	0	0	0	N/A
1994	1990	0	0	0	0	0	8,510
1995	1990	0	0	0	95	95	9,750
1996	1990	0	0	0	0	0	8,744
1997	1990	0	0	0	0	0	10,001
1998	1990	0	0	0	0	0	9,222
1999	1990	0	0	0	95	95	9,249
2000	2000	0	0	0	0	0	7,361
2001	2000	0	0	0	0	0	4,508
2002	2000	0	0	0	0	0	3,995
2003	2000	0	0	0	0	0	3,591
2004 [4]	2000	0	0	0	0	0	7,756
2005 [4]	2000	0	0	0	0	0	5,772
2006 [4]	2000	0	0	0	0	0	2,477
2007 [4,5]	2000	0	0	0	0	0	9,774
2008 [4,5]	2000	0	0	0	0	0	7,793
2009 [4,5]	2000	0	0	0	0	0	5,462

Table H-11	Noise-Exposed Population by Community (Continued)						
Year	Census Data	80+ dB	75+ dB	70-75 dB DNL	65-70 dB DNL[1]	Total (65+)	60-65 dB DNL
CHELSEA							
2010 [4,5]	2010	0	0	0	0	0	4,897
2011 [4,5]	2010	0	0	0	0	0	0
2012 [4,5]	2010	0	0	0	0	0	0
2013 [4,5]	2010	0	0	0	0	0	3,485
2014 [4,5]	2010	0	0	0	0	0	9,236
2015 [4,5]	2010	0	0	0	0	0	0
2016 [4,5]	2010	0	0	0	0	0	12,110
2017 [4,5]	2010	0	0	0	65	65	13,900
EVERETT							
1990	1980	0	0	0	0	0	N/A
1992	1980	0	0	0	0	0	N/A
1993	1980	0	0	0	0	0	N/A
1994	1990	0	0	0	0	0	0
1995	1990	0	0	0	0	0	0
1996	1990	0	0	0	0	0	0
1997	1990	0	0	0	0	0	0
1998	1990	0	0	0	0	0	0
1999	1990	0	0	0	0	0	0
2000	2000	0	0	0	0	0	0
2001	2000	0	0	0	0	0	0
2002	2000	0	0	0	0	0	0
2003	2000	0	0	0	0	0	0
2004 [4]	2000	0	0	0	0	0	0
2005 [4]	2000	0	0	0	0	0	0
2006 [4]	2000	0	0	0	0	0	0
2007 [4,5]	2000	0	0	0	0	0	0
2008 [4,5]	2000	0	0	0	0	0	0
2009 [4,5]	2000	0	0	0	0	0	0
2010 [4,5]	2010	0	0	0	0	0	0
2011 [4,5]	2010	0	0	0	0	0	0
2012 [4,5]	2010	0	0	0	0	0	0
2013 [4,5]	2010	0	0	0	0	0	0
2014 [4,5]	2010	0	0	0	0	0	0
2015 [4,5]	2010	0	0	0	0	0	0
2016 [4,5]	2010	0	0	0	0	0	0
2017 [4,5]	2010	0	0	0	0	0	924
MEDFORD							
1990	1980	0	0	0	0	0	N/A
1992	1980	0	0	0	0	0	N/A
1993	1980	0	0	0	0	0	N/A
1994	1990	0	0	0	0	0	0
1995	1990	0	0	0	0	0	0
1996	1990	0	0	0	0	0	0
1997	1990	0	0	0	0	0	0
1998	1990	0	0	0	0	0	0
1999	1990	0	0	0	0	0	0
2000	2000	0	0	0	0	0	0

Table H-11 Noise-Exposed Population by Community (Continued)

Year	Census Data	80+ dB	75+ dB	70-75 dB DNL	65-70 dB DNL[1]	Total (65+)	60-65 dB DNL
MEDFORD							
2001	2000	0	0	0	0	0	0
2002	2000	0	0	0	0	0	0
2003	2000	0	0	0	0	0	0
2004 [4]	2000	0	0	0	0	0	0
2005 [4]	2000	0	0	0	0	0	0
2006 [4]	2000	0	0	0	0	0	0
2007 [4,5]	2000	0	0	0	0	0	0
2008 [4,5]	2000	0	0	0	0	0	0
2009 [4,5]	2000	0	0	0	0	0	0
2010 [4,5]	2010	0	0	0	0	0	0
2011 [4,5]	2010	0	0	0	0	0	0
2012 [4,5]	2010	0	0	0	0	0	0
2013 [4,5]	2010	0	0	0	0	0	0
2014 [4,5]	2010	0	0	0	0	0	0
2015 [4,5]	2010	0	0	0	0	0	0
2016 [4,5]	2010	0	0	0	0	0	0
2017 [4,5]	2010	0	0	0	0	0	0
QUINCY							
1990	1980	0	0	0	0	0	N/A
1992	1980	0	0	0	0	0	N/A
1993	1980	0	0	0	0	0	N/A
1994	1990	0	0	0	0	0	0
1995	1990	0	0	0	0	0	0
1996	1990	0	0	0	0	0	0
1997	1990	0	0	0	0	0	0
1998	1990	0	0	0	0	0	0
1999	1990	0	0	0	0	0	0
2000	2000	0	0	0	0	0	636
2001	2000	0	0	0	0	0	610
2002	2000	0	0	0	0	0	610
2003	2000	0	0	0	0	0	610
2004 [4]	2000	0	0	0	0	0	610
2005 [4]	2000	0	0	0	0	0	610
2006 [4]	2000	0	0	0	0	0	610
2007 [4,5]	2000	0	0	0	0	0	0
2008 [4,5]	2000	0	0	0	0	0	0
2009 [4,5]	2000	0	0	0	0	0	0
2010 [4,5]	2010	0	0	0	0	0	0
2011 [4,5]	2010	0	0	0	0	0	0
2012 [4,5]	2010	0	0	0	0	0	0
2013 [4,5]	2010	0	0	0	0	0	0
2014 [4,5]	2010	0	0	0	0	0	0
2015 [4,5]	2010	0	0	0	0	0	0
2016 [4,5]	2010	0	0	0	0	0	0
2017 [4,5]	2010	0	0	0	0	0	0

Table H-11 Noise-Exposed Population by Community (Continued)

Year	Census Data	80+ dB	75+ dB	70-75 dB DNL	65-70 dB DNL[1]	Total (65+)	60-65 dB DNL
REVERE							
1990	1980	0	0	0	4,274	4,274	N/A
1992	1980	0	0	0	3,848	3,848	N/A
1993	1980	0	0	0	4,617	4,617	N/A
1994	1990	0	0	0	3,569	3,569	2,099
1995	1990	0	0	0	3,364	3,364	2,304
1996	1990	0	0	172	3,292	3,464	2,505
1997	1990	0	0	0	3,293	3,293	2,047
1998	1990	0	0	0	3,168	3,168	2,132
1999	1990	0	0	128	3,165	3,293	2,047
2000	2000	0	0	0	2,496	2,496	3,100
2001	2000	0	0	0	2,496	2,496	3,100
2002	2000	0	0	0	2,822	2,822	2,399
2003	2000	0	0	0	2,994	2,994	2,227
2004 [4]	2000	0	0	82	2,969	3,051	2,678
2005 [4]	2000	0	0	82	2,540	2,622	2,731
2006 [4]	2000	0	0	82	2,540	2,622	2,698
2007 [4,5]	2000	0	0	0	2,450	2,450	2,853
2008 [4,5]	2000	0	0	0	2,434	2,434	1,802
2009 [4,5]	2000	0	0	0	2,512	2,512	1,452
2010 [4,5]	2010	0	0	0	2,413	2,413	2,473
2011 [4,5]	2010	0	0	0	2,547	2,547	3,123
2012 [4,5]	2010	0	0	0	2,762	2,762	3,191
2013 [4,5]	2010	0	0	0	2,505	2,505	2,791
2014 [4,5]	2010	0	0	0	2,832	2,832	3,829
2015 [4,5]	2010	0	0	0	3,789	3,789	3,385
2016 [4,5]	2010	0	0	0	2,376	2,376	3,508
2017 [4,5]	2010	0	0	0	2,362	2,362	2,899
WINTHROP							
1990	1980	0	676	1,211	2,420	4,307	N/A
1992	1980	0	626	1,146	2,488	4,262	N/A
1993	1980	0	648	1,211	1,773	3,632	N/A
1994	1990	0	417	1,343	5,154	6,914	7,512
1995	1990	0	482	1,611	5,757	7,850	7,077
1996	1990	0	417	1,376	5,930	7,723	7,333
1997	1990	0	417	1,659	6,386	8,462	6,839
1998	1990	0	519	1,522	6,572	8,613	6,507
1999	1990	0	353	1,408	5,946	7,707	7,135
2000	2000	0	247	1,070	4,684	6,001	7,776
2001	2000	0	244	683	4,123	5,050	8,104
2002	2000	0	2	481	2,247	2,730	7,921
2003	2000	0	0	339	1,956	2,295	7,386
2004 [4]	2000	0	2	337	1,649	1,988	6,508
2005 [4]	2000	0	39	347	1,280	1,666	6,353
2006 [4]	2000	0	39	416	1,288	1,743	6,845
2007 [4,5]	2000	0	0	247	1,139	1,386	6,749
2008 [4,5]	2000	0	0	244	1,409	1,653	6,547
2009 [4,5]	2000	0	0	171	643	814	4,221
2010 [4,5]	2010	0	0	130	598	728	3,720

Table H-11 Noise-Exposed Population by Community (Continued)

Year	Census Data	80+ dB	75+ dB	70-75 dB DNL	65-70 dB DNL[1]	Total (65+)	60-65 dB DNL
WINTHROP							
2011 [4,5]	2010	0	0	130	939	1069	4,303
2012 [4,5]	2010	0	0	200	1,186	1,386	5,305
2013 [4,5]	2010	0	0	130	1,060	1,190	5,466
2014 [4,5]	2010	0	0	130	1,775	1,905	6,456
2015 [4,5]	2010	0	0	320	2,623	2,943	6,375
2016 [4,5]	2010	0	0	130	913	1,403	5,062
2017 [4,5]	2010	0	0	125	647	772	4,656
All Communities							
1990	1980	0	676	2,989	40,477	44,142	NA
1992	1980	0	628	2,352	14,604	17,584	NA
1993	1980	0	648	1,475	9,210	11,333	NA
1994	1990	0	523	1,608	16,421	18,552	49,016
1995	1990	0	588	2,462	18,031	21,081	52,896
1996	1990	0	523	1,922	17,997	20,442	59,574
1997	1990	0	523	2,378	23,536	26,437	73,691
1998	1990	0	577	2,102	20,617	23,296	70,062
1999[3]	1990	0	411	1,900	20,838	23,149	64,379
2000	2000	0	247	1,304	16,194	17,745	54,190
2001	2000	0	244	998	13,004	14,246	43,616
2002	2000	0	2	613	7,694	8,309	38,150
2003	2000	0	0	503	6,680	7,183	35,577
2004 [4]	2000	0	67	611	8,760	9,438	41,975
2005 [4]	2000	0	104	533	5,840	6,477	33,127
2006 [4]	2000	0	104	597	4,882	5,583	27,496
2007 [4,5]	2000	0	0	416	7,683	8,099	40,822
2008 [4,5]	2000	0	5	244	7,330	7,579	35,122
2009 [4,5]	2000	0	5	238	4,092	4,335	23,419
2010 [4,5]	2010	0	0	130	3,700	3,830	28,736
2011 [4,5]	2010	0	0	130	3,817	3,947	19,026
2012 [4,5]	2010	0	0	200	4,369	4,569	19,533
2013 [4,5]	2010	0	0	130	4,177	4,307	26,577
2014 [4,5]	2010	0	0	164	8,758	8,922	42,864
2015 [4,5]	2010	0	0	430	13,667	14,097	52,748
2016 [4,5]	2010	0	0	130	7,320	7,450	41,486
2017 [4,5]	2010	0	0	139	7,794	7,933	46,974

Source: Data prepared for Massport by HMMH 2018.
Notes: dB – decibel; DNL - Day-Night Average Sound Level; N/A – not available.
South End is included in Boston totals.
1 65 dB DNL is the federally-defined noise criterion.
2 Boston includes portions of Dorchester, East Boston, Roxbury, South Boston.
3 Boston population by community changed in 1999 due to employment of more accurate hill effects methodology and reporting change.
4 All results from 2004 to 2015 are from the RealContours™ modeling system with INM.
All results from 2016 and 2017 are from AEDT using the RC for AEDT™ pre-processor.
5 2017 noise analysis uses AEDT version 2d, 2016 used AEDT version 2c SP2, 2012 through 2015 used INM version 7.0d, 2011 used INM version 7.0c, 2008 through 2010 used INM version 7.0b, 2007 used INM version 7.01, and 1990 and 2000 used earlier versions of INM.

Cumulative Noise Index (CNI)

Massport reports total annual fleet noise at Logan Airport, defined in the Logan Airport Noise Rules by a metric referred to as the CNI. The CNI is a single number representing the sum of the entire set of single-event noise levels experienced at the Airport over a full year of operation, weighted similarly to DNL so that activity occurring at night is penalized by adding an extra 10 dB to each event. This penalty is mathematically equivalent to multiplying the number of nighttime events by each aircraft by a factor of ten. The Logan Airport Noise Rules define CNI in terms of Effective Perceived Noise Level (EPNL) and require that the index be computed for the fleet of commercial aircraFft operating at Logan Airport throughout the year. In addition, in EDRs and ESPRs, Massport reports partial CNI values of noise at Logan Airport, so that various subsets of the fleet (cargo, night operations, passenger jets, etc.) are identified (see **Table H-12**). The Noise Rules, adopted by Massport following public hearings held in February 1986, established a CNI limit of 156.5 EPNdB. The CNI generally has decreased since 1990, remaining below that cap, with changes from year to year on the order of a few tenths of a decibel. The 2017 CNI remains well below the cap of 156.5 EPNL.

Table H-12 Cumulative Noise Index (EPNL) – 1990 to 2017 (limit 156.5)

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Full CNI (Entire Commercial Jet Fleet)	**156.4**	**155.8**	**155.5**	**155.3**	**155.4**	**155.3**	**155.1**	**154.8**	**154.7**	**154.9**
Total Passenger Jets	155.2	154.8	154.6	154.4	154.4	154.2	154.1	153.9	153.7	153.9
Total Cargo Jets	150.1	148.9	148.0	147.9	148.3	148.8	148.6	147.5	147.9	148.0
Total Daytime	152.5	152.1	152.4	152.1	152.1	151.6	151.2	150.8	150.4	150.4
Total Nighttime	154.4	153.4	152.6	152.4	152.6	152.9	152.9	152.5	152.7	153.1
Total Stage 2 Jets	N/A	N/A	N/A	N/A	151.0	150.2	149.4	149.2	147.7	147.1
Total Stage 3 Jets	N/A	N/A	N/A	N/A	153.4	153.8	153.8	153.4	153.8	154.2
Daytime Stage 2	N/A	N/A	N/A	N/A	149.0	148.5	147.6	146.5	145.2	144.1
Nighttime Stage 2	N/A	N/A	N/A	N/A	146.7	145.1	144.8	145.8	144.1	144.0
Daytime Stage 3	N/A	N/A	N/A	N/A	149.1	148.8	148.7	148.8	148.9	149.2
Nighttime Stage 3	N/A	N/A	N/A	N/A	151.4	152.1	152.2	151.5	152.1	152.5
Passenger Jet Stage 2	N/A	N/A	N/A	N/A	150.5	149.9	149.2	148.9	147.5	146.8
Passenger Jet Stage 3	N/A	N/A	N/A	N/A	152.2	152.3	152.3	152.2	152.6	153.0
Cargo Jet Stage 2	N/A	N/A	N/A	N/A	141.5	137.4	136.8	137.4	139.0	134.5
Cargo Jet Stage 3	N/A	N/A	N/A	N/A	147.3	148.5	148.3	147.0	147.3	147.9
Daytime Passenger	N/A	152.0	152.2	152.0	152.0	151.5	151.1	150.6	150.1	150.1
Nighttime Passenger	N/A	151.6	150.9	150.6	150.8	151.0	151.0	151.1	151.2	151.6
Daytime Cargo	137.1	137.1	137.6	135.2	136.1	138.0	136.7	136.2	138.0	138.2
Nighttime Cargo	149.9	148.6	147.6	147.6	148.0	148.4	148.3	147.1	147.5	147.6
Daytime Passenger Stage 2	N/A	N/A	N/A	N/A	148.9	148.4	147.6	146.5	145.0	143.9
Daytime Passenger Stage 3	N/A	N/A	N/A	N/A	149.0	148.5	148.4	148.5	148.6	149.0
Nighttime Passenger Stage 2	N/A	N/A	N/A	N/A	149.0	148.5	148.4	148.5	142.8	143.7
Nighttime Passenger Stage 3	N/A	N/A	N/A	N/A	149.4	149.9	150.1	149.8	150.5	150.8
Daytime Cargo Stage 2	N/A	N/A	N/A	N/A	128.3	126.7	124.6	126.4	131.6	131.5
Daytime Cargo Stage 3	N/A	N/A	N/A	N/A	135.3	137.7	136.4	135.7	136.9	137.1
Nighttime Cargo Stage 2	N/A	N/A	N/A	N/A	141.3	137.0	136.5	137.0	138.2	131.5
Nighttime Cargo Stage 3	N/A	N/A	N/A	N/A	147.0	148.1	148.0	146.6	146.9	147.5

Table H-12 Cumulative Noise Index (EPNL) – 1990 to 2017 (limit 156.5) (Continued)

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Full CNI (Entire Commercial Jet Fleet)	**154.7**	**154.1**	**153.2**	**152.7**	**153.4**	**153.2**	**152.6**	**152.7**	**152.9**	**152.3**
Total Passenger Jets	153.6	152.9	151.8	151.3	152.2	152.1	151.4	151.5	151.9	151.1
Total Cargo Jets	148.2	147.8	147.4	147.1	147.0	146.6	146.5	146.4	146.1	145.9
Total Daytime	149.5	149.0	148.5	148.0	148.5	148.2	147.5	147.2	147.6	147.1
Total Nighttime	153.1	152.4	151.3	150.9	151.7	151.6	151.0	151.2	151.4	150.7
Total Stage 2 Jets	124.7	121.5	114.3	114.1	118.1	N/A	N/A	N/A	N/A	N/A
Total Stage 3 Jets	154.7	154.1	153.2	152.7	153.4	153.2	152.0	152.7	152.9	152.3
Daytime Stage 2	122.6	119.3	111.2	113.7	109.4	N/A	N/A	N/A	N/A	N/A
Nighttime Stage 2	120.5	117.3	111.4	103.2	117.5	N/A	N/A	N/A	N/A	N/A
Daytime Stage 3	149.5	149.0	148.5	148.0	148.5	148.2	147.5	147.2	147.6	147.1
Nighttime Stage 3	153.1	152.4	151.3	150.9	151.7	151.6	151.0	151.2	151.4	150.7
Passenger Jet Stage 2	124.2	116.3	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Passenger Jet Stage 3	153.6	152.9	151.8	151.3	152.2	152.1	151.4	151.5	151.9	151.1
Cargo Jet Stage 2	114.8	119.9	114.3	114.1	118.1	NA	NA	NA	NA	NA
Cargo Jet Stage 3	148.2	147.8	147.4	147.1	147.0	146.6	146.5	146.4	146.1	145.9
Daytime Passenger	149.3	148.7	148.2	147.7	148.2	147.9	147.2	146.9	147.3	146.8
Nighttime Passenger	151.6	150.8	149.4	148.8	150.0	150.1	149.3	149.7	150.0	149.1
Daytime Cargo	137.5	137.1	137.0	136.2	135.7	135.8	135.5	135.8	135.8	135.2
Nighttime Cargo	147.8	147.4	147.0	146.8	146.7	146.2	146.1	146.0	145.6	145.5
Daytime Passenger Stage 2	122.3	115.0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Daytime Passenger Stage 3	149.2	148.7	148.2	147.7	148.2	147.9	147.2	146.9	147.3	146.8
Nighttime Passenger Stage 2	119.8	110.2	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Nighttime Passenger Stage 3	151.6	150.8	149.4	148.8	150.0	150.1	149.3	149.7	150,.0	149.1
Daytime Cargo Stage 2	111.1	117.3	111.2	113.7	109.4	N/A	N/A	N/A	N/A	N/A
Daytime Cargo Stage 3	137.5	137.0	137.0	136.1	135.7	135.8	135.5	135.8	135.8	135.2
Nighttime Cargo Stage 2	112.3	116.4	111.4	103.2	117.5	N/A	N/A	N/A	N/A	N/A
Nighttime Cargo Stage 3	147.8	147.4	147.0	146.8	146.7	146.2	146.1	146.0	145.6	145.5

Table H-12 Cumulative Noise Index (EPNL) – 1990 to 2017 (limit 156.5) (Continued)

	2010	2011	2012	2013	2014[1]	2015	2016	2017	Change 2016 to 2017
Full CNI (Entire Commercial Jet Fleet)	**151.9**	**152.1**	**152.2**	**152.3**	**152.9**	**152.7**	**152.6**	**153.1**	**0.5**
Total Passenger Jets	150.9	150.6	151.3	151.4	151.7	152.0	152.0	152.6	0.6
Total Cargo Jets	145.1	146.7	144.9	145.1	144.5	144.2	143.8	143.4	(0.4)
Total Daytime	146.8	146.9	147.0	147.0	147.1	147.2	147.0	147.5	0.5
Total Nighttime	150.3	150.6	150.6	150.8	151.0	151.2	151.2	151.7	0.5
Total Stage 2 Jets	113.6	110.8	104.9	111.3	N/A	N/A	N/A	NA	N/A
Total Stage 3 Jets	151.9	152.1	152.2	152.3	152.5	152.7	152.6	153.1	0.5
Daytime Stage 2	103.6	N/A	104.9	101.4	N/A	N/A	N/A	NA	N/A
Nighttime Stage 2	113.1	110.8	N/A	110.8	N/A	N/A	N/A	NA	N/A
Daytime Stage 3	146.8	146.9	147.0	147.0	147.1	147.2	147.0	147.5	0.5
Nighttime Stage 3	150.3	150.6	150.6	150.8	151.0	151.2	151.2	151.7	0.5
Passenger Jet Stage 2	N/A	N/A	104.9	101.4	N/A	N/A	N/A	NA	N/A
Passenger Jet Stage 3	150.9	150.6	151.3	151.4	151.7	152.0	152.0	152.6	0.6
Cargo Jet Stage 2	113.6	110.8	N/A	110.8	N/A	N/A	N/A	NA	N/A
Cargo Jet Stage 3	145.1	146.7	144.9	145.1	144.5	144.2	143.8	143.4	(0.4)
Daytime Passenger	146.6	146.5	146.8	146.8	146.9	147.0	146.8	147.3	0.5
Nighttime Passenger	149.0	148.5	149.4	149.6	150.0	150.3	150.4	151.1	0.7
Daytime Cargo	134.5	136.6	134.0	133.6	134.9	134.4	133.8	133.9	0.1
Nighttime Cargo	144.7	146.3	144.5	144.8	144.0	143.7	143.4	142.8	(0.6)
Daytime Passenger Stage 2	N/A	N/A	104.9	101.4	N/A	N/A	N/A	NA	N/A
Daytime Passenger Stage 3	146.6	146.5	146.8	146.8	146.9	147.0	146.8	147.3	0.5
Nighttime Passenger Stage 2	N/A	N/A	N/A	N/A	N/A	N/A	N/A	NA	N/A
Nighttime Passenger Stage 3	149.0	148.5	149.4	149.6	150.0	150.3	150.4	151.1	0.7
Daytime Cargo Stage 2	103.6	N/A	N/A	N/A	N/A	N/A	N/A	NA	N/A
Daytime Cargo Stage 3	134.4	136.6	134.0	133.6	134.9	134.4	133.8	133.9	0.1
Nighttime Cargo Stage 2	113.1	110.8	N/A	110.8	N/A	N/A	N/A	NA	N/A
Nighttime Cargo Stage 3	144.7	146.3	144.5	144.8	144.0	143.7	143.4	142.8	(0.6)

Source: HMMH, 2018.

Notes: CNI – cumulative noise index; EPNL - Effective Perceived Noise Level; N/A – not available.
General aviation (GA) aircraft and non-jet aircraft are not included in the calculations. Negative numbers are shown in parentheses ( ).

1 The 2014 CNI analysis contained errors which appeared in the *2014 EDR* and *2015 EDR*. The analysis has been corrected and the numbers presented in this table have been updated.

Residential Sound Insulation Program (RSIP)

In 2017, no new dwelling units received sound insulation from Massport, with a total of 5,467 residential buildings and 11,515 dwelling units that have been sound insulated since 1986 when the program was first implemented. **Table H-13** lists the yearly progress of this mitigation effort.

Following FAA's approval of model adjustments based on the effects of terrain (discussed in the *1999 ESPR*), Massport submitted, and the New England Region of FAA approved, a new sound insulation program. The revised contour, approved for a two-year period beginning in 1999, included dwelling units in East Boston, South Boston, and Winthrop that previously had not been eligible for insulation. Massport received notice of FAA funding for $5 million. Subsequently, Massport updated its program contour, first with the *2001 EDR* contour and more recently with the Logan Airside Improvements Project approved contour. These updates have allowed Massport to continue the program with additional funds every year since 1999. The Logan Airside Improvements Project update takes into account runway use changes due to the new Runway 14-32 which opened in late November 2006. The Logan Airside Improvements Project update expands the focus of the sound insulation program into Chelsea to satisfy the mitigation commitments made in the Airside Improvements Program Record of Decision (ROD). Massport has also utilized a program where they have contacted property owners that are still eligible within the RSIP boundaries that had previously declined to participate. Owners have been offered a second chance to participate in the program.

Table H-13 Residential Sound Insulation Program (RSIP) Status (1986-2017)

Construction Year	Residential Buildings[1]	Dwelling Units[2]
1986	4	8
1987	43	51
1988	102	159
1989	94	133
1990	121	200
1991	175	360
1992	197	354
1993	318	654
1994	310	542
1995	372	753
1996	323	577
1997	364	808
1998	328	806
1999	330	718
2000	195	601
2001	260	278
2002	205	354
2003	230	468
2004	320	791
2005	314	471
2006	286	827
2007	160	548
2008	94	388
2009	111	287
2010	56	83
2011	62	114
2012[3]	0	0
2013	45	76
2014	48	106
2015	0	0
2016	0	0
2017	0	0
Total	**5,467**	**11,515**

Source: Massport, 2017.
1 Includes multiple units.
2 Individual units.
3 Federal funding was delayed in 2012.

Table H-14 provides a list of all schools that have been treated under Massport's sound insulation program. To date, Massport has provided sound insulation to 36 schools at a cost of over $8 million.

Table H-14 Schools Treated Under Massport Sound Insulation Program

Boston:	
East Boston	**Winthrop**
East Boston High	Winthrop Jr. High School
St. Mary's Star of the Sea	E. B. Newton
St. Dominic Savio High	A. T. Cummings (Ctr.) School
St. Lazarus	*3 Winthrop Schools*
James Otis	
Samuel Adams	
Curtis Guild	**Revere**
Dante Alighieri	Beachmont School
P.J. Kennedy	*1 Revere School*
Donald McKay	
Hugh Roe O'Donnell	
E Boston Central Catholic	**Chelsea**
Manassah Bradley	Shurtleff School
13 East Boston Schools	Williams School
	St. Rose Elementary
South Boston	St. Stanislaus
St. Augustine	Chelsea High School
Cardinal Cushing	*5 Chelsea Schools*
Patrick Gavin	
St. Bridgid's	**36 Total Schools**
Oliver Hazard Perry	
Condon School	
6 South Boston Schools	
Roxbury and Dorchester	
Samuel Mason	
Dearborn Middle	
Ralph Waldo Emerson	
Lewis Middle	
Nathan Hale Elem.	
Phillis Wheatley Elem.	
Davis Ellis Elem.	
Henry L. Higginson	
8 Roxbury and Dorchester Schools	
27 Total Boston Schools	

Source: Massport, 2015.

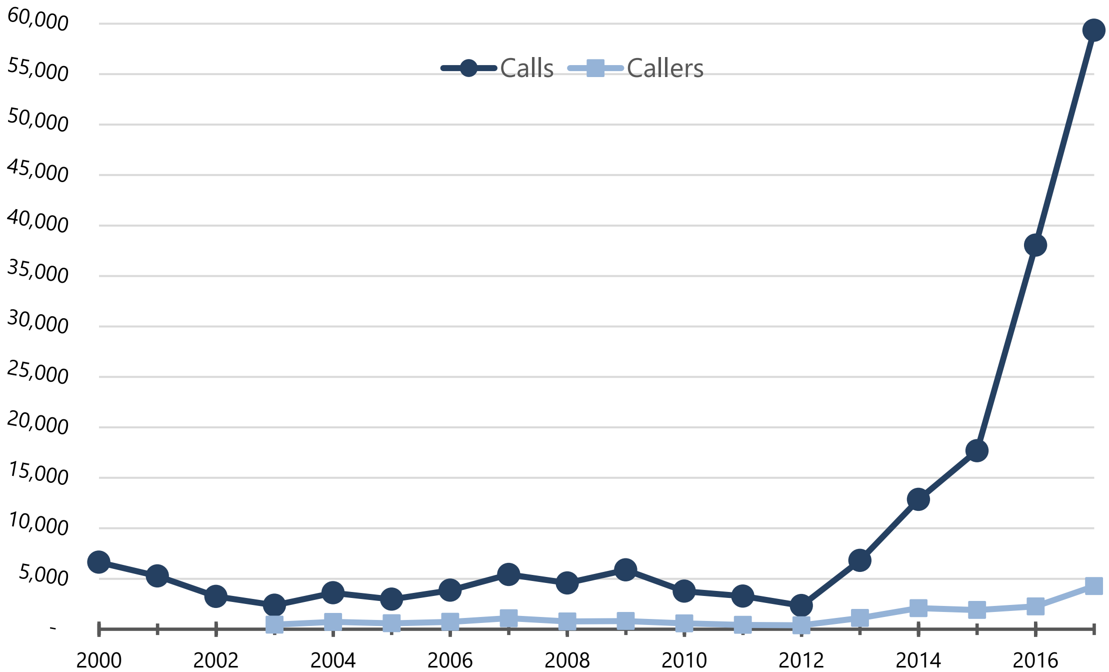
Noise Complaints

Table H-15 presents a detailed list by community of the total noise complaints made in 2017 and 2016, which can be filed either on Massport's Noise Complaint Line, through a form on Massport's website, or through the PublicVue flight track portal. The Noise Complaint Line provides individuals the ability to express their concerns about aviation noise (activities) or to ask questions regarding noise at Logan Airport. Callers ask a range of questions such as "Why is this runway in use?"; "What times do the planes stop flying?"; and "Was that aircraft off-course?"

The Noise Abatement Office (NAO) staff documents noise line complaints by obtaining information from the caller about the nature of the complaint, time of the occurrence, location of caller's residence, and the activity that was disturbed. The NAO uses the collected information to determine the probable activity responsible for the complaint and writes a letter report to the complainant. The letter includes the original complaint, a response that identifies the activity responsible for the call (arrivals, departures, run-up, etc.), meteorological information at the time of the call (a major factor in aviation activities), runways in use at the time of the call, and a notice that FAA will receive a copy of the report.

In 2017, Massport received 59,343 noise complaints from 95 communities (**Figure H-13)**, an increase from 38,045 complaints from 83 communities in 2016. The number of individual complainants increased to 4,269 callers in 2017 from 2,260 callers in 2016. The increase in complaints from 2016 to 2017 is 56 percent, and the increase in number of individual callers is almost 89 percent. In 2016, the average number of complaints per individual caller (the ratio of calls to callers) was 16.8. In 2017, this ratio decreased to an average 13.9 complaints per caller. Massport's website, http://www.massport.com/logan-airport/about-logan/noise-abatement/complaints/), provides for additional general questions and answers regarding the Noise Complaint Line. Part of the explanation of the increase numbers of calls is due to recent technological advances in both Massport's noise complaint phone system, online complaint tracking system and incorporation of third-party complaint applications, which have made it easier for community members to file a complaint and to receive information about particular noise events.

Figure H-13 Noise Complaint Line Calls and Callers by Year



Source: Massport

Table H-15 Noise Complaint Line Summary

	2016		2017		
Town Name	**Calls**	**Callers**	**Calls**	**Callers**	**Change in number of calls**
Acton	0	0	2	2	2
Allston	1	1	0	0	(1)
Andover	0	0	4	2	4
Arlington	1,968	87	2,252	137	284
Belmont	501	63	1,129	102	628
Beverly	4	4	15	4	11
Billerica	1	1	8	5	7
Boston	78	24	186	59	108
Braintree	12	5	29	4	17
Brewster	0	0	1	1	1
Brighton	0	0	2	2	2
Brookline	5	4	4	3	(1)
Burlington	0	0	22	14	22
Cambridge	2,154	128	1,657	211	(497)
Canton	20	6	19	7	(1)
Carlisle	0	0	3	1	3
Charlestown	25	13	31	16	6

Table H-15 Noise Complaint Line Summary (Continued)

	2016		2017		
Town Name	**Calls**	**Callers**	**Calls**	**Callers**	**Change in number of calls**
Chelmsford	1	1	1	1	0
Chelsea	146	39	428	117	282
Cohasset	125	8	214	13	89
Danvers	9	4	0	0	(9)
Dedham	6	4	4	3	(2)
Dorchester	326	36	519	60	193
Dover	0	0	10	3	10
Dunstable	0	0	3	1	3
Duxbury	1	1	1	1	0
East Boston	203	61	312	97	109
Easton	0	0	1	1	1
Essex	1	1	0	0	(1)
Everett	84	25	335	118	251
Framingham	6	2	2	2	(4)
Gloucester	0	0	10	2	10
Groton	0	0	88	1	88
Groveland	1	1	1	1	0
Hamilton	42	15	53	22	11
Hanover	0	0	3	2	3
Hingham	68	18	67	27	(1)
Holbrook	11	2	10	2	(1)
Hull	1,266	220	1,500	175	234
Hyde Park	190	8	132	20	(58)
Ipswich	10	5	104	28	94
Jamaica Plain	434	76	2,016	274	1,582
Lincoln	0	0	114	1	114
Littleton	11	1	0	0	(11)
Lowell	0	0	1	1	1
Lynn	323	15	276	10	(47)
Lynnfield	2	2	1	1	(1)
Malden	10	7	1,987	96	1,977
Manchester	6	2	1	1	(5)
Marblehead	14	4	18	4	4
Marshfield	3	3	13	6	10
Mattapan	2	2	4	2	2
Medfield	1	1	1	1	0
Medford	1,784	177	7,856	745	6,072
Melrose	9	4	5	2	(4)

Table H-15 Noise Complaint Line Summary (Continued)

	2016		2017		
Town Name	**Calls**	**Callers**	**Calls**	**Callers**	**Change in number of calls**
Middleton	3	2	4	2	1
Millis	113	2	132	1	19
Milton	21,796	466	23,940	486	2,144
Nahant	339	12	117	18	(222)
Natick	10	1	1	1	(9)
Needham	51	5	36	8	(15)
Newton	44	19	319	25	275
North End	1	1	0	0	(1)
Norwell	13	1	7	4	(6)
Norwood	0	0	1	1	1
Peabody	72	6	61	6	(11)
Pembroke	4	2	5	1	1
Quincy	28	16	44	33	16
Randolph	7	3	3	2	(4)
Reading	0	0	13	9	13
Rehoboth	1	1	0	0	(1)
Revere	87	33	134	47	47
Roslindale	588	103	2,094	203	1,506
Rowley	1	1	0	0	(1)
Roxbury	286	40	891	36	605
Salem	26	8	6	3	(20)
Saugus	4	1	4	2	0
Scituate	37	10	8	6	(29)
Sharon	2	1	3	3	1
Shirley	0	0	1	1	1
Shrewsbury	1	1	0	0	(1)
Somerville	1,804	153	3,762	309	1,958
South Boston	577	42	1,792	78	1,215
South End	294	40	786	135	492
Stoneham	24	6	2	2	(22)
Stoughton	21	2	21	3	0
Sudbury	116	1	105	1	(11)
Swampscott	0	0	4	3	4
Topsfield	0	0	2	2	2
Waban	0	0	1	1	1
Wakefield	25	2	47	7	22
Waltham	1	1	6	5	5
Watertown	265	38	818	65	553

Table H-15 Noise Complaint Line Summary (Continued)

	2016		2017		
Town Name	**Calls**	**Callers**	**Calls**	**Callers**	**Change in number of calls**
Wellesley	1	1	1	1	0
Wenham	416	9	116	11	(300)
West Roxbury	170	21	1,104	56	934
Weston	1	1	0	0	(1)
Westwood	56	4	157	3	101
Weymouth	125	5	92	5	(33)
Whitman	0	0	2	1	2
Wilmington	1	1	3	3	2
Winchester	489	16	895	111	406
Winthrop	271	96	293	128	22
Woburn[1]	10	5	55	30	45
Total	**38,045**	**2,260**	**59,343**	**4,269**	**21,298**

Source: Massport, HMMH 2017.
Note: Negative numbers are shown in parentheses ( ).
1 Woburn data omitted in *2016 EDR* documentation; included here with totals corrected.

AEDT Correspondence

Massport engaged in an extensive process with FAA New England Region and the FAA Office of Environment and Energy (AEE-100) upon the release of AEDT. This process was to develop and gain concurrence on the use of Logan Airport specific modifications to the AEDT model and inputs. Meetings and discussion were held in 2016 and 2017 to determine what adjustments Massport could make to the AEDT model to account for Logan Airport's unique terrain. The complete set of correspondence which determined the AEDT adjustments for the 2016 DNL contours is provided in the *2016 EDR Appendix H*.

In August 2017, the FAA expressed concurrence, in principal, with two of Massport's four requested adjustments; that response letter is included below. For the 2017 noise modeling, Massport applied the two allowed adjustments, using the same methodology as 2016.

FAA Response (dated August 18, 2017) to AEDT Non-Standard Modeling Request

U.S. Department
of Transportation
**Federal Aviation
Administration**

Office of Environment and Energy

800 Independence Ave., S.W.
Washington, D.C. 20591

8/18/2017

Richard Doucette
Airports Division
Federal Aviation Administration, New England Region
1200 District Avenue
Burlington, MA 01803

Dear Richard,

The Office of Environment and Energy (AEE) has received the memo dated July 12th 2017, requesting FAA-AEE concurrence on non-standard AEDT modeling adjustments and inputs for noise modeling at Boston Logan International Airport as submitted by HMMH on behalf of Massachusetts Port Authority (HMMH Project Number 307500.003.004).

As highlighted in the request and understood by FAA-AEE, this memo requests concurrence and not approval for the non-standard modeling elements presented. A specific project requiring FAA review and use of the proposed non-standard elements has not been identified; therefore any findings of concurrence detailed in this response are for reference only as they relate to a level of understanding and capability with AEDT 2c SP2 and at the time of this response.

Any findings of concurrence detailed here are therefore subject to change under future updates to AEDT or any relevant technical or policy updates. Formal approval of any proposed non-standard elements will require additional project specific approval by FAA-AEE.

Section 2.1 Overwater Adjustment: Adjustments to departure Noise-Power-Distance curves for Start-of-Takeoff Roll (STR) noise to emulate acoustic overwater propagation.

AEE **DOES NOT CONCUR** with the proposed process as it is not adequately supported through the presentation of a defensible technical analysis or current research findings and is therefore not suitable for use with AEDT.

Section 2.2 Hill Effects Adjustment: Contour grid adjustments to emulate ground propagation effects in the presence of terrain.

AEE **DOES NOT CONCUR** with the proposed process as it is not adequately supported through the presentation of a defensible technical analysis or current research findings and is therefore not suitable for use with AEDT.

Section 2.3 Stage Length Selection: Modified Stage Lengths Selection Based on US DOT BTS T100 Data

AEE **CONCURS IN PRINCIPAL** with the use of US DOT BTS T100 data as a method to evaluate stage length selections. However, due to the specific nature of matching annual flight operations to T100 data, any approval would still require evaluation on a case by cases basis. AEE agrees that the T100 data is a reasonable reference to complete this review, but cautions that since the data may only provide supporting information for existing conditions that there could be concerns when applying any proposed stage length modification assumptions to future year modeling cases. Further supporting information may therefore be required for proposed use with future case modeling conditions. In order to ensure consistent stage length considerations for all modeling cases, it remains AEEs recommendation to continue use of the industry standard city-pair method.

Section 2.4 Non-standard Weather Data: Average Calendar Year 2015 Weather Data Parameters for Temperature, Pressure and Relative Humidity from the National Climatic Data Center (NCDC) are requested for use with Calendar Year 2015 modeling inputs.

AEE **CONCURS IN PRINCIPAL** with the use of the NCDC data to determine appropriate annual average weather data parameters. Please note however that the format of weather parameter inputs for AEDT has been updated compared with INM. Each of the following parameters, in the units specified, must be provided when a formal review for approval is requested:

Temperature (°F)
Pressure (millibars)
Sea Level Pressure (millibars)
Relative humidity (%)
Dew Point (°F)
[Average] Wind Speed (knots)

3

As described above please understand that this memo provides a record of concurrence and not approval for the non-standard modeling elements presented; and that a specific project, AEDT model version and timeframe would need to be identified before formal approval could be granted. Findings of concurrence are therefore for reference only as they relate to a level of understanding and capability with AEDT 2c SP2 and at the time of this response.

Sincerely,

Rebecca S Cointin

Rebecca Cointin
Manager
AEE/Noise Division

cc: Jim Byers, Jean Wolfers-Lawrence (APP)

Flight Track Monitoring Report

As part of its ongoing commitment to mitigate noise at Logan Airport, Massport has undertaken evaluating the flight tracks of turbojet aircraft engaged in the implementation of established FAA noise abatement procedures. As is true for any airport operator, however, Massport has no authority to control where individual aircraft fly. That remains the responsibility of FAA, while the individual pilots are responsible for safely executing FAA's instructions. The flight procedures, which are used by the Air Traffic Control (ATC) staff at Boston Tower to achieve desired noise abatement tracks, are contained in FAA's Tower Order (BOS TWR 7040.1).

This is the sixteenth annual report for flight track monitoring. Prior to 2002, Massport had issued semi-annual reports, an outgrowth of the Flight Track Monitoring Program study. That study was contained in the *Generic Environmental Impact Report* filed with Massachusetts Environmental Policy Act (MEPA) in July 1996 and was the subject of two Community Working Group workshops in September and October 1996. The fifteenth annual flight and monitoring report was published in Appendix H, *Noise Abatement* in the *2016 EDR*. The information for 2016 is repeated in this report for reference. The period covered by this *2017 ESPR* is January 1, 2017 through December 31, 2017.

The purpose of the ongoing monitoring program is to identify any systematic changes in flight tracks that may occur and to reduce flight track dispersion, where appropriate. The next report will cover the period January 1, 2018 through December 31, 2018 and will be included in the next EDR.

FAA Air Traffic Control (ATC) Procedures

FAA Tower Order BOS TWR 7040.1 entitled "Noise Abatement" describes the series of noise abatement policies, rules, regulations, and the procedures to be followed by FAA air traffic controllers in meeting their designated responsibilities to be "a good neighbor, while meeting our operational objectives/ responsibilities to the National Airspace System." Section 7.a.3 of the Order, subtitled "Turbojet Departure Noise Abatement Procedures," states that all turbojet departures shall be issued the Standard Instrument Departure (SID) procedure appropriate for the departure runway. Logan Airport has ten published SIDs; nine area navigation (RNAV) SIDs and one conventional SID.

The conventional SID is for aircraft that are not equipped to fly RNAV procedures. The conventional SID uses terms such as "BOS 2 DME" to indicate where aircraft should turn. Here, BOS refers to an aid to navigation known as the BOSTON VORTAC, a radio beacon physically located on Logan Airport near the eastern shoreline between the ends of Runways 27 and 33L (see **Figure H-14**). DME refers to "Distance Measuring Equipment," a co-located aid to navigation that provides pilots with a cockpit display of the number of nautical miles that the aircraft is from the designated radio beacon. Thus, BOS 2 DME means an aircraft should be two nautical miles away from the BOS. Pilots are then "vectored" or assigned to fly a magnetic heading given by and at the discretion of FAA air traffic controller to maintain the safe separation of aircraft. All altitudes in feet listed below (unless otherwise noted) are in mean sea level (MSL) and i indicate the aircraft altitude used both by the pilot in the cockpit and the air traffic controller on the ground.

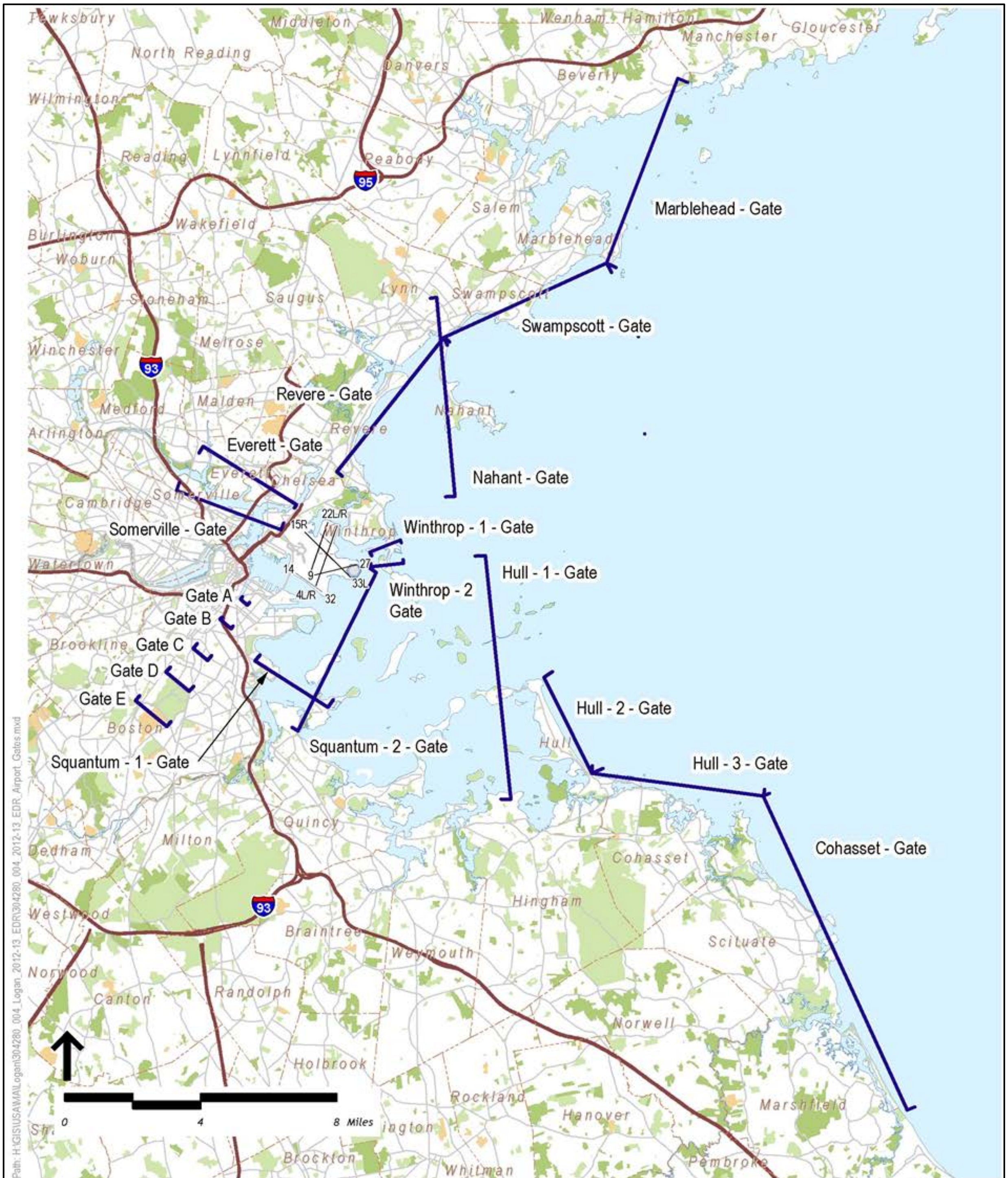
During 2010, several of the conventional-only (or radar vector) and RNAV procedures from the *Boston Logan Airport Noise Study Categorical Exclusion* (CATEX)[17] were implemented. There are eight RNAV procedures for departures from Logan Airport. These eight procedures are used by aircraft departing Runways 4R, 9, 15R, 22L, 22R, 27, and 33L (Runways 27 and 33L were added in 2014). These procedures primarily affected departures flying over the North and South shores and were designed to increase the amount of jet traffic crossing back over land above 6,000 feet to minimize noise impacts to communities. A ninth RNAV procedure, which is used by Runway 27, has been modified several times.

Figure H-14 presents the gates used in the analysis for the Flight Track Monitoring Report. These gates are virtual vertical planes, which are used in the analysis to capture the aircraft flight paths. The gates are defined using a geographic coordinate for each end of the gate along with a floor and a ceiling altitude. The gates also capture direction of flights (in or out). The edges of each gate in **Figure H-14** point in the direction that the aircraft is coming from. This information is used to evaluate the performance of the flight procedures off each runway end and is presented below. **Figure H-14** also displays the BOS location, which is used for the distance measurements for the conventional procedures.

The RNAV procedures are still captured by the original flight track monitoring gates. Traffic crossing over the North Shore passes through the Marblehead Gate and traffic passing over the South Shore passes through the Hull 2, Hull 3, and Cohasset Gates. Turbojets departing Runway 27 on the RNAV pass through the Runway 27 gates and the new Runway 33L RNAV flight tracks still pass between the Somerville and Everett gates as expected.

17 Federal Aviation Administration (FAA) *Boston Logan Airport Noise Study Categorical Exclusion Record of Decision* (CATEX ROD), Issued October 16, 2007.

Figure H-14 Logan Airport Flight Track Monitor Gates



Source: HMMH, MassGIS, USDA NAIP 2010

Logan Airport Flight Track Monitor Gates

Figure H-14

Logan Flight Gates

Boston VOR/DME

Statistical Analyses of Flight Tracks - Runway 4R

The Nahant Gate (**Figure H-14**) monitors aircraft after the first turn at 4 DME. The Swampscott and Marblehead Gates monitor northbound shoreline crossings, while the Hull 2, Hull 3, and Cohasset Gates monitor southbound shoreline crossings.

Tables H-16a and **H-16b** show that Runway 4R departures for 2017 were concentrated, with 99.5 percent "over the Causeway," about 0.1 percent over the south end of the gate, and about 0.5 percent over the north end of the gate, the same percentages observed for 2016.

Table H-16a Runway 4R Nahant Gate Summary for 2016

	Number of Tracks Through Gate Segment	Percentage of Tracks Through Gate Segment
North End of Gate	31	0.5%
Over Causeway	6,814	99.5%
South End of Gate	5	0.1%
Total	**6,850**	**100.0%**

Source: Massport, HMMH 2017.

Table H-16b Runway 4R Nahant Gate Summary for 2017

	Number of Tracks Through Gate Segment	Percentage of Tracks Through Gate Segment
North End of Gate	18	0.5%
Over Causeway	3,798	99.5%
South End of Gate	3	0.1%
Total	**3,819**	**100.0%**

Source: Massport, HMMH 2018.

Table H-17a and **H-17b** show how many of the shoreline crossings from Runway 4R were above 6,000 feet. For 2017, 96.1 percent of the flights were above 6,000 feet compared to 98.3 percent in 2016. The Swampscott gate had the lowest percent of flights above 6,000 feet in 2017, at only 16.9 percent, after showing an unusually high 97.9 percent in 2016. However, the number of flights through the Swampscott gate decreased to 83 in 2017, down from 234 in 2016. The crossing percentage for this gate is historically lower than most gates due to its proximity to the Nahant gate itself. As seen in **Figure H-14**, the Swampscott gate is adjacent to the Nahant gate and aircraft would have to climb very quickly to be above 6,000 feet when crossing the Swampscott gate.

Table H-17a Runway 4R Shoreline Crossings Above 6,000 Feet for 2016

	Number of Tracks Through Gate	Number Above 6,000 ft	Percentage Above 6,000 ft
Swampscott Gate	234	229	97.9%
Marblehead Gate	2,532	2,531	100.0%
Hull 2 Gate	82	18	22.0%
Hull 3 Gate	386	354	91.7%
Cohasset Gate	3,032	3,030	99.9%
Total	**6,266**	**6,162**	**98.3%**

Source: Massport, HMMH 2017.

Table H-17b Runway 4R Shoreline Crossings Above 6,000 Feet for 2017

	Number of Tracks Through Gate	Number Above 6,000 ft	Percentage Above 6,000 ft
Swampscott Gate	83	14	16.9%
Marblehead Gate	1,538	1,509	98.1%
Hull 2 Gate	160	160	100.0%
Hull 3 Gate	608	07	99.8%
Cohasset Gate	124	124	100.0%
Total	**2,513**	**2,414**	**96.1%**

Source: Massport, HMMH 2018.

Statistical Analyses of Flight Tracks - Runway 9

The Winthrop 1 and Winthrop 2 gates (**Figure H-14**) monitor early turns for departures off Runway 9. The Revere, Swampscott, or Marblehead gates monitor northbound shoreline crossings, while the Hull 2, Hull 3, or Cohasset gates monitor southbound shoreline crossings.

Tables H-18a and **H-18b** show how many tracks turned prior to the BOS 2 DME. Northbound turns before BOS 2 DME pass through the Winthrop 1 Gate. Southbound traffic would pass through the Winthrop 2 Gate. In 2016, there were a total of 52 such turns and in 2017, 65 tracks crossed these gates. The compliance rate for avoiding the early turns was 99.9% in 2016 and 99.8% in 2017.

Table H-18a Runway 9 Gate Summary — Winthrop Gates 1 and 2 for 2016

	Number of Tracks Through Gate	Percent Turning Before BOS 2 DME
Winthrop 1 Gate	18	<0.1%
Winthrop 2 Gate	34	0.1%
Neither gate	55,830	99.9%
Total	**55,882**	**100%**

Source: Massport, HMMH 2017.
Note: DME – distance measuring equipment.

Table H-18b Runway 9 Gate Summary — Winthrop Gates 1 and 2 for 2017

	Number of Tracks Through Gate	Percent Turning Before BOS 2 DME
Winthrop 1 Gate	37	0.1%
Winthrop 2 Gate	28	0.1%
Neither gate	43,771	99.8%
Total	**43,836**	**100%**

Source: Massport, HMMH 2018.
Note: DME – distance measuring equipment.

Table H-19a and **H-19b** indicate that 99.5 percent of Runway 9 departures were above 6,000 feet when crossing the shoreline in 2017, compared with 99.4 percent in 2016. In both years, approximately 65 percent of aircraft departing Runway 9 that cross back over the shoreline do so over the South Shore[18], as opposed to about 35 percent over the North Shore.

The percentages above 6,000 feet remained fairly constant from 2016 to 2017, with the Revere gate (36.5 percent in 2016 to 72.7 percent in 2017) appearing to be the most variable, but with only 33 flights through that gate in the entire year (less than one per week, on average).

Table H-19a Runway 9 Shoreline Crossings Above 6,000 Feet for 2016

	Number of Tracks Through Gate	Number Above 6,000 ft	Percentage Above 6,000 ft
Revere Gate	63	23	36.5%
Swampscott Gate	537	495	92.2%
Marblehead Gate	12,489	12,471	99.9%
Hull 2 Gate	2,379	2,367	99.5%
Hull 3 Gate	6,052	5,971	98.7%
Cohasset Gate	15,497	15,484	99.9%
Total	**37,017**	**36,811**	**99.4%**

Source: Massport, HMMH 2017.

18 The 2016 EDR erroneously stated "The number of Runway 9 departures crossing back over the South Shore increased from 33,807 in 2015 to 36,811 in 2016." In reality, only 23,822 of those departures crossed over the south shore: through the Hull or Cohasset gates. In 2015 that number was 21,843.

Table H-19b Runway 9 Shoreline Crossings Above 6,000 Feet for 2017

	Number of Tracks Through Gate	Number Above 6,000 ft	Percentage Above 6,000 ft
Revere Gate	33	24	72.7%
Swampscott Gate	470	435	92.6%
Marblehead Gate	10,645	10,628	99.8%
Hull 2 Gate	1,656	1,648	99.5%
Hull 3 Gate	3,393	3,327	98.1%
Cohasset Gate	15,441	15,427	99.9%
Total	**31,638**	**31,489**	**99.5%**

Source: Massport, HMMH 2018.

Statistical Analyses of Flight Tracks - Runway 15R

After takeoff, Runway 15R departures turn left approximately 30 degrees to avoid Hull, head out over Boston Harbor, and return over the shore through the Swampscott and Marblehead Gates (**Figure H-14**) to the north, or through the Hull 2, Hull 3, and Cohasset Gates to the south. The initial turn and success rate in avoidance of Hull overflights is shown, combined with departures from Runways 22L and 22R, in the next section in **Tables H-22a** and **H-22b**.

Tables H-20a and **H-20b** indicate that over 99 percent of Runway 15R departures were above 6,000 feet when crossing the shoreline in both 2016 and 2017. While compliance at the Swampscott, Marblehead, and Cohasset gates at close to 98 percent or better for both 2016 and 2017, the proportion of flights over 6,000 feet at the Hull 3 gate[19] fell from 92.1 percent in 2016 to 89.1 percent in 2017. Very few departures from Runway 15R cross back over the Hull 2 gate.

Table H-20a Runway 15R Shoreline Crossings Above 6,000 Feet for 2016

	Number of Tracks Through Gate	Number Above 6,000 ft	Percentage Above 6,000 ft
Swampscott Gate	234	229	97.9%
Marblehead Gate	2,532	2,531	100.0%
Hull 2 Gate	16	13	81.3%
Hull 3 Gate	382	352	92.1%
Cohasset Gate	3,015	3,013	99.9%
Total	**6,179**	**6,138**	**99.3%**

Note: This table differs from that included in *2016 EDR* due to removal of gate crossings in opposite direction.
Source: Massport, HMMH 2017.

19 The 2016 EDR contained the text "the proportion of flights over 6,000 feet at the Hull 2 gate fell from 94.3 percent in 2015 to 91.7 percent in 2016, and only 22 percent of flights crossed the Hull 1 gate over 6,000 feet in 26, compared to perfect compliance for 2015" which mis-identified the gate names, accidentally called the year 26 instead of 2016, and included opposite direction gate crossings in its analysis.

Table H-20b Runway 15R Shoreline Crossings Above 6,000 Feet for 2017

	Number of Tracks Through Gate	Number Above 6,000 ft	Percentage Above 6,000 ft
Swampscott Gate	280	277	98.9%
Marblehead Gate	2,771	2,770	100.0%
Hull 2 Gate	16	16	100.0%
Hull 3 Gate	266	237	89.1%
Cohasset Gate	2,246	2,242	99.8%
Total	**5,579**	**5,542**	**99.3%**

Source: Massport, HMMH 2018.

Statistical Analyses of Flight Tracks - Runways 22R and 22L

The Squantum 2 and Hull 1 Gates (**Figure H-14**) are used to monitor the turn to 140 degrees over Boston Harbor and then passage north of Hull. The shoreline gates are used to monitor shoreline crossings, as for Runways 4R, 9, and 15R above.

Tables H-21a and **H-21b** show the dispersion of the jet departures from Runways 22R and 22L as they pass through the Squantum 2 Gate. The first segment of the 27,000-foot wide gate is the northernmost segment and is primarily over Boston Harbor. The subsequent segments extend southward toward Quincy. The percentage of tracks passing through the first two segments of this gate, representing compliance with the noise abatement procedures, increased from 88.8 percent in 2016 to 93.2 percent in 2017.

Table H-21a Runways 22R and 22L Squantum 2 Gate[1] Summary for 2016

	Number of Tracks Through Gate Segment	Percentage of Tracks Through Gate Segment
0 - 12,000 ft	870	1.8%
12,000 - 14,000 ft	41,218	87.0%
14,000 - 21,000 ft	5,247	11.1%
21,000 - 27,000 ft	36	0.1%
Total	**47,371**	**100.0%**

Source: Massport, HMMH 2017.
Notes:
1 The 27,000-foot wide Squantum 2 Gate is divided into four segments, identified in this table by distance from the northernmost point.

Table H-21b Runways 22R and 22L Squantum 2 Gate Summary for 2017

	Number of Tracks Through Gate Segment	Percentage of Tracks Through Gate Segment
0 - 12,000 ft	4,425	8.9%
12,000 - 14,000 ft	42,067	84.3%
14,000 - 21,000 ft	3,361	6.7%
21,000 - 27,000 ft	66	0.1%
Total	**49,919**	**100.0%**

Source: Massport, HMMH 2018.

1 The 27,000-foot wide Squantum 2 Gate is divided into four segments, identified in this table by distance from the northernmost point.

Massport uses the Hull 1 Gate to monitor departures from Runways 22R and 22L as well as from Runway 15R as they make their initial turn over Boston Harbor. **Tables H-22a** and **H-22b** show that the percent of tracks crossing north of the Hull peninsula as they passed through the Hull 1 Gate remained at 98.7 percent for both 2016 and 2017.

Table H-22a Runways 15R, 22R, and 22L Hull 1 Gate Summary for 2016

	Number of Tracks Through Gate Segment	Percentage of Tracks Through Gate Segment
North of Hull Peninsula	57,059	98.7%
Over Hull	775	1.3%
Total	**57,834**	**100.0%**

Source: Massport, HMMH 2017.

Table H-22b Runways 15R, 22R, and 22L Hull 1 Gate Summary for 2017

	Number of Tracks Through Gate Segment	Percentage of Tracks Through Gate Segment
North of Hull Peninsula	58,420	98.7%
Over Hull	764	1.3%
Total	**59,184**	**100.0%**

Source: Massport, HMMH 2018.

Tables H-23a and **H-23b** indicate the percent of Runway 22R and 22L departures that were above 6,000 feet when crossing the shoreline. Compliance was above 97.0 percent for the Swampscott, Marblehead, Hull 3, and Cohasset gates for both years. The Hull 2 gate and the Revere gate which are the closest to the airport on the south and north shores, respectively, have the fewest crossings and also the lowest compliance rates. Overall compliance in crossing back over the shoreline at 6,000 feet altitude or higher was 99.8 percent for both 2016 and 2017.

Table H-23a Runways 22R and 22L Shoreline Crossings Above 6,000 Feet for 2016

	Number of Tracks Through Gate	Number Above 6,000 ft	Percentage Above 6,000 ft
Revere Gate	106	95	89.6%
Swampscott Gate	951	951	100.0%
Marblehead Gate	12,250	12,245	100.0%
Hull 2 Gate	24	21	87.5%
Hull 3 Gate	2,082	2,035	97.7%
Cohasset Gate	18,017	18,006	99.9%
Total	**33,430**	**33,353**	**99.8%**

Source: Massport, HMMH 2017.
Note: This table differs from that included in 2016 EDR due to removal of gate crossings in opposite direction.

Table H-23b Runways 22R and 22L Shoreline Crossings Above 6,000 Feet for 2017

	Number of Tracks Through Gate	Number Above 6,000 ft	Percentage Above 6,000 ft
Revere Gate	58	55	94.8%
Swampscott Gate	797	796	99.9%
Marblehead Gate	12,645	12,639	100.0%
Hull 2 Gate	36	33	91.7%
Hull 3 Gate	1,608	1,565	97.3%
Cohasset Gate	19,978	19,963	99.9%
Total	**35,122**	**35,051**	**99.8%**

Source: Massport, HMMH 2018.

Statistical Analyses of Flight Tracks - Runway 27

On September 15, 1996, FAA implemented a new departure procedure for Runway 27 called the WYLYY RNAV procedure. In accordance with the provisions of the ROD issued for the Runway 27 Environmental Impact Statement, Massport has been providing on-going radar flight track data and analysis to FAA with respect to the procedure.

In 2012, for the first time since 1997 when flight track monitoring began, each gate (Gates A through E) averaged over 68 percent for every month the Airport had all runways open and for the annual average. The percent of flight tracks through all gates (a number tracked but not required per the 1996 ROD) rounded up to 68 percent for the last two months of 2011 and continued for all of 2012. FAA had discussed these data internally and concluded that acceptable flight track dispersion had been achieved and that no subsequent action by FAA is required per the 1996 ROD requirements.[20]

Massport continues to provide **Tables H-24a** and **H-24b** in the subsequent annual reports. **Table H-24a** presents the conformance results for the Runway 27 corridor for 2016 and **Table H-24b** for 2017. Gate A

20 Logan Airport Runway 27 Advisory Committee Meeting - January 23, 2012 meeting minutes.

is closest to the airport, with each subsequently labeled gate further from the runway. The gates increase in width as the distance is increased along the flight path, together forming a noise abatement corridor. A consistent percentage of traffic through each gate means that flights are not entering the corridor late or exiting the corridor too early. The average percentage of tracks through the entire corridor was 80.6 percent for 2016 and 84.9 percent for 2017. The average percent through each gate was 95.0 percent in 2016 and 94.0 percent for 2017.

Table H-24a Runway 27 Corridor Percent of Tracks Through Each Gate for 2016

Month	Total # of Tracks	Total # of Tracks Through All Gates	Percent of Tracks Through All Gates	Gate A	Gate B	Gate C	Gate D	Gate E	Average Percent Through Each Gate
				1,400[1]	2,200[1]	2,900[1]	4,700[1]	6,300[1]	
January	2,345	1,790	76.3%	1,849	2,256	2,297	2,313	2,299	93.9%
February	1,968	1,560	79.3%	1,618	1,908	1,930	1,950	1,930	94.9%
March	1,895	1,509	79.6%	1,569	1,821	1,851	1,856	1,857	94.5%
April	1,148	936	81.5%	972	1,115	1,130	1,127	1,106	94.9%
May	988	809	81.9%	828	944	959	968	969	94.5%
June	1,358	1,048	77.2%	1,085	1,311	1,332	1,370	1,378	95.4%
July	1,823	1,510	82.8%	1,565	1,746	1,782	1,795	1,793	95.2%
August	837	703	84.0%	721	810	825	829	840	96.2%
September	737	614	83.3%	630	708	720	733	742	95.9%
October	2,285	1,808	79.1%	1,860	2,204	2,239	2,246	2,252	94.5%
November	2,703	2,169	80.2%	2,226	2,609	2,645	2,674	2,670	94.9%
December	2,926	2,380	81.3%	2,448	2,808	2,862	2,897	2,886	95.0%
Average	**1,751**	**1,403**	**80.6%**	**1,448**	**1,687**	**1,714**	**1,730**	**1,727**	**95.0%**

Source: Massport, HMMH 2017.

1 The numbers below the gate names indicate the width of each gate, in feet.

Table H-24b Runway 27 Corridor Percent of Tracks Through Each Gate for 2017

Month	Total # of Tracks	Total # of Tracks Through All Gates	Percent of Tracks Through All Gates	Gate A 1,400[1]	Gate B 2,200[1]	Gate C 2,900[1]	Gate D 4,700[1]	Gate E 6,300[1]	Average Percent Through Each Gate
January	2,257	1,811	80.2%	1,843	2,012	2,060	2,079	2,074	89.2%
February	1,883	1,597	84.8%	1,635	1,797	1,844	1,858	1,847	95.4%
March	2,513	2,140	85.2%	2,198	2,428	2,468	2,485	2,467	95.9%
April	1,152	954	82.8%	983	1,063	1,082	1,089	1,082	92.0%
May	2,200	1,894	86.1%	1,925	2,113	2,168	2,183	2,179	96.1%
June	2,412	2,131	88.3%	2,165	2,331	2,381	2,397	2,386	96.7%
July	1,922	1,729	90.0%	1,762	1,860	1,901	1,909	1,898	97.1%
August	2,335	1,956	83.8%	1,994	2,109	2,169	2,186	2,170	91.0%
September	2,377	2,110	88.8%	2,149	2,292	2,348	2,367	2,353	96.8%
October	1,627	1,426	87.6%	1,452	1,569	1,593	1,613	1,605	96.3%
November	2,177	1,762	80.9%	1,795	1,991	2,038	2,048	2,036	91.0%
December	2,776	2,240	80.7%	2,314	2,533	2,589	2,610	2,573	90.9%
Average	**2,136**	**1,813**	**84.9%**	**1,851**	**2,008**	**2,053**	**2,069**	**2,056**	**94.0%**

Source: Massport, HMMH 2018.
1 The numbers below the gate names indicate the width of each gate, in feet.

Statistical Analyses of Flight Tracks — Runway 33L

The Somerville and Everett Gates (**Figure H-14**) extend from BOS 2 DME to BOS 5 DME and are used to monitor the departure procedure for Runway 33L. Turns to the left prior to the BOS 5 DME would pass through the Somerville Gate. Turns to the right prior to the BOS 5 DME would pass through the Everett Gate.

Tables H-25a and **H-25b** indicate that the percentage of tracks below 3,000 feet turning before BOS 5 DME was 1.5 percent in both 2016 and 2017. The total number of jet departure tracks from Runway 33L increased from 29,854 in 2016 to 40,347 in 2017.

Table H-25a Runway 33L Gates — Passages Below 3,000 Feet for 2016

	Number of Tracks Turning Before BOS 5 DME	Percentage of Tracks Turning Before BOS 5 DME
Everett Gate	214	0.7%
Somerville Gate	228	0.8%
Neither gate below 3,000 ft	29,402	98.5%
Total	**29,854**	**100.0%**

Source: Massport, HMMH 2017.
Notes: This table differs slightly from that included in *2016 EDR* due to removal of gate crossings in opposite direction.

Table H-25b Runway 33L Gates — Passages Below 3,000 Feet for 2017

	Number of Tracks Turning Before BOS 5 DME	Percentage of Tracks Turning Before BOS 5 DME
Everett Gate	262	0.6%
Somerville Gate	358	0.9%
Neither gate below 3,000 ft	39,727	98.5%
Total	**40,347**	**100.0%**

Source: Massport, HMMH 2018.

2017 DNL Levels for Census Block Group Locations

Table H-26 reports the DNL value for each Census block group down to the DNL 50 dB computed with AEDT. A Census Block Group represents the outer limits of a group of US Census Blocks. The Average Block DNL provided below is the arithmetic average of the DNL modeled at each US Census Block in that group. The DNL at centroid represents the DNL modeled at the geographic center of the US Census Block Group.

Table H-26 2017 DNL Levels for Census Block Group Locations within DNL 50 dB

U.S. Census 2010 Block Group					
Block Group ID	**Name**	**Population**	**Housing units**	**Average Block DNL**	**DNL at centroid**
250173561001	Arlington	795	368	50.7	50.7
250173561002	Arlington	1,460	681	51.2	51.2
250173561003	Arlington	855	400	50.1	50.3
250173563001	Arlington	1,239	604	50.6	50.2
250173567011	Arlington	1,316	610	51.2	51.3
250173567012	Arlington	1,131	606	50.1	50.2
250173567015	Arlington	621	341	50.0	50.1
250250105002	Back Bay	1,099	744	51.1	51.1
250250105003	Back Bay	992	674	51.5	51.5
250250106001	Back Bay	1,559	1,383	51.2	51.0
250250106002	Back Bay	1,299	942	51.6	51.7
250250107021	Back Bay	663	482	51.0	51.3
250250107022	Back Bay	775	465	50.2	50.2
250250107023	Back Bay	962	696	51.3	51.2
250250108011	Back Bay	664	354	50.8	50.8
250250108012	Back Bay	964	678	50.2	50.2
250250707001	Back Bay	1,161	644	52.7	52.7
250250708003	Back Bay	1,072	612	52.1	52.1
250250201011	Beacon Hill	767	480	51.2	51.2
250250201012	Beacon Hill	896	691	50.7	50.6

Table H-26	2017 DNL Levels for Census Block Group Locations within DNL 50 dB (Continued)				
U.S. Census 2010 Block Group					
Block Group ID	**Name**	**Population**	**Housing units**	**Average Block DNL**	**DNL at centroid**
250250201013	Beacon Hill	1,268	821	51.5	51.6
250250201014	Beacon Hill	1,262	822	51.0	51.0
250250202001	Beacon Hill	1,266	897	51.3	51.4
250250202002	Beacon Hill	1,259	847	51.0	51.0
250250202003	Beacon Hill	1,124	734	50.5	50.4
250250203021	Beacon Hill	1,181	721	52.0	52.1
250250303003	Beacon Hill	1,305	503	53.1	53.0
250250701013	Beacon Hill	494	381	53.8	53.8
250173572001	Belmont	1,083	422	50.0	50.0
250250104042	Brighton	2,548	245	49.9	50.0
250250104051	Brighton	2,591	6	49.8	50.3
250250104053	Brighton	626	355	51.0	51.1
250250105001	Brighton	953	349	49.6	50.1
250250105003	Brighton	992	674	51.5	51.5
250173521012	Cambridge	1,473	1,187	49.2	50.0
250173543003	Cambridge	1,121	555	49.3	50.4
250173544001	Cambridge	812	389	49.9	50.1
250173546001	Cambridge	2,116	1,019	50.2	50.4
250173546003	Cambridge	853	413	50.6	50.9
250173546004	Cambridge	832	392	50.5	50.9
250173547001	Cambridge	1,258	596	50.7	50.7
250173547002	Cambridge	1,251	611	50.3	50.3
250173548001	Cambridge	911	444	52.0	52.0
250173548002	Cambridge	992	533	51.2	51.3
250173549001	Cambridge	1,126	535	51.8	51.9
250173549002	Cambridge	3,201	1,231	51.5	51.6
250173549003	Cambridge	1,731	866	51.8	51.2
250173550001	Cambridge	671	331	51.9	51.9
250173550002	Cambridge	1,183	645	52.2	52.2
250173550003	Cambridge	835	437	52.1	52.2
250250401001	Charlestown	958	555	52.3	52.3
250250401002	Charlestown	1,210	684	51.7	51.8
250250402001	Charlestown	775	304	54.3	54.4
250250402002	Charlestown	831	423	53.1	53.1
250250403001	Charlestown	739	334	53.4	53.4
250250403002	Charlestown	1,247	662	52.4	52.4
250250403003	Charlestown	657	366	52.5	52.6

Table H-26 2017 DNL Levels for Census Block Group Locations within DNL 50 dB (Continued)

U.S. Census 2010 Block Group					
Block Group ID	**Name**	**Population**	**Housing units**	**Average Block DNL**	**DNL at centroid**
250250403004	Charlestown	617	320	53.0	53.0
250250403005	Charlestown	622	355	52.0	52.0
250250404011	Charlestown	1,689	766	51.4	51.3
250250404012	Charlestown	750	456	51.4	51.0
250250406001	Charlestown	863	485	51.8	52.9
250250406002	Charlestown	1,581	843	52.4	52.5
250250408011	Charlestown	1,061	530	53.8	53.8
250250408012	Charlestown	828	263	55.2	56.7
250250408013	Charlestown	2,011	1,296	54.5	54.7
250251601011	Chelsea	1,332	353	62.5	62.4
250251601012	Chelsea	1,372	438	60.5	60.5
250251601013	Chelsea	1,730	568	62.1	63.3
250251601014	Chelsea	2,092	539	59.4	59.4
250251601015	Chelsea	1,025	261	64.0	64.2
250251602001	Chelsea	1,336	357	61.9	61.9
250251602002	Chelsea	1,210	374	63.3	63.3
250251602003	Chelsea	1,497	494	64.4	64.6
250251603001	Chelsea	1,469	913	61.7	61.2
250251603002	Chelsea	596	366	63.1	62.8
250251604001	Chelsea	933	344	60.8	60.9
250251604002	Chelsea	1,783	683	62.2	61.8
250251605011	Chelsea	2,097	646	56.6	56.5
250251605012	Chelsea	1,231	396	56.7	56.9
250251605013	Chelsea	774	233	58.3	58.2
250251605014	Chelsea	754	392	57.2	57.1
250251605015	Chelsea	748	304	55.9	56.1
250251605021	Chelsea	1,703	623	55.0	56.4
250251605022	Chelsea	1,359	477	52.9	55.0
250251605023	Chelsea	1,398	488	56.2	55.9
250251606011	Chelsea	2,158	1,005	53.4	52.9
250251606012	Chelsea	1,905	563	54.6	54.6
250251606021	Chelsea	1,290	470	54.1	53.9
250251606022	Chelsea	795	304	51.8	51.7
250251606023	Chelsea	825	346	50.2	50.3
250251606024	Chelsea	780	271	51.6	51.6
250251606025	Chelsea	985	409	52.6	52.4

Table H-26 2017 DNL Levels for Census Block Group Locations within DNL 50 dB (Continued)

U.S. Census 2010 Block Group					
Block Group ID	**Name**	**Population**	**Housing units**	**Average Block DNL**	**DNL at centroid**
250250701011	Chinatown	850	529	57.3	58.2
250250702001	Chinatown	1,460	599	56.1	56.2
250250702003	Chinatown	2,625	647	54.9	54.9
250250801001	Dorchester	2,612	450	56.9	57.3
250250907001	Dorchester	1,218	518	52.9	53.1
250250907002	Dorchester	1,253	644	54.2	54.3
250250907003	Dorchester	1,153	526	53.3	53.3
250250907004	Dorchester	651	302	55.4	56.1
250250909011	Dorchester	1,627	606	52.5	52.3
250250909012	Dorchester	2,103	1,034	53.7	54.7
250250910011	Dorchester	650	248	50.4	50.4
250250910012	Dorchester	743	363	50.4	50.0
250250910013	Dorchester	682	335	50.9	51.9
250250910014	Dorchester	667	369	51.3	51.1
250250911001	Dorchester	1,395	625	51.7	51.7
250250911002	Dorchester	1,007	465	50.9	50.8
250250911003	Dorchester	929	325	51.1	51.1
250250911004	Dorchester	713	254	51.3	51.4
250250911005	Dorchester	817	297	52.1	52.1
250250912001	Dorchester	1,081	451	53.0	53.1
250250912002	Dorchester	1,411	492	52.0	52.0
250250912003	Dorchester	742	296	53.0	53.1
250250913001	Dorchester	1,368	480	54.2	54.2
250250913002	Dorchester	1,131	388	55.3	55.4
250250914001	Dorchester	1,672	584	53.4	53.7
250250915001	Dorchester	1,978	744	51.9	51.7
250250915002	Dorchester	1,494	547	51.8	51.7
250250915003	Dorchester	898	362	50.8	50.6
250250916001	Dorchester	1,205	445	50.0	50.1
250250917002	Dorchester	988	337	50.1	50.1
250250917003	Dorchester	775	244	50.1	50.1
250250918001	Dorchester	1,517	517	51.7	51.7
250250918002	Dorchester	1,002	340	51.3	51.5
250250918003	Dorchester	933	357	51.5	51.6
250250919001	Dorchester	1,042	329	51.3	51.3
250250919002	Dorchester	709	280	50.4	50.4

Table H-26 2017 DNL Levels for Census Block Group Locations within DNL 50 dB (Continued)

U.S. Census 2010 Block Group					
Block Group ID	**Name**	**Population**	**Housing units**	**Average Block DNL**	**DNL at centroid**
250250919003	Dorchester	1,522	551	50.6	50.7
250250921011	Dorchester	1,113	467	52.0	52.1
250250921013	Dorchester	729	321	51.5	52.8
250251006011	Dorchester	1,094	488	53.3	53.3
250251006012	Dorchester	898	382	51.8	51.7
250251006013	Dorchester	1,218	535	50.1	50.1
250251006031	Dorchester	1,306	556	56.0	56.3
250251006032	Dorchester	598	284	57.8	58.4
250251007001	Dorchester	1,050	484	54.8	54.8
250251007002	Dorchester	1,027	526	56.1	57.2
250251007003	Dorchester	672	290	56.0	56.1
250251007004	Dorchester	856	371	53.6	53.7
250251007005	Dorchester	717	303	52.9	52.9
250251008002	Dorchester	929	378	51.2	51.3
250251008003	Dorchester	899	412	51.4	51.4
250251008004	Dorchester	1,117	666	51.5	52.4
250250203011	Downtown	350	205	50.9	50.5
250250203012	Downtown	1,673	1,209	50.6	50.6
250250203031	Downtown	878	693	51.3	51.3
250250203032	Downtown	1,343	365	51.8	51.3
250250203033	Downtown	1,179	789	50.8	50.8
250250301001	Downtown	1,053	790	53.0	53.0
250250301002	Downtown	901	587	52.7	52.6
250250302001	Downtown	1,665	1,103	52.9	52.9
250250303001	Downtown	1,757	1,283	55.4	56.0
250250303002	Downtown	1,262	696	54.4	54.5
250250303003	Downtown	1,305	503	53.1	53.0
250250303004	Downtown	548	465	54.2	54.6
250250304001	Downtown	1,519	994	53.7	53.5
250250304002	Downtown	932	665	53.6	53.5
250250305001	Downtown	704	442	54.3	53.9
250250305002	Downtown	1,025	687	54.1	54.0
250250305003	Downtown	809	527	53.7	53.7
250250701011	Downtown	850	529	57.3	58.2
250250701012	Downtown	303	90	54.8	54.8
250250701013	Downtown	494	381	53.8	53.8

Table H-26	2017 DNL Levels for Census Block Group Locations within DNL 50 dB (Continued)				
U.S. Census 2010 Block Group					
Block Group ID	**Name**	**Population**	**Housing units**	**Average Block DNL**	**DNL at centroid**
250250701014	Downtown	1,887	941	54.1	54.1
250250701015	Downtown	451	161	54.5	54.4
250250701016	Downtown	366	325	54.7	54.7
250250701017	Downtown	1,102	701	55.7	55.8
250250701018	Downtown	449	246	56.0	56.2
250250702002	Downtown	1,133	444	56.6	56.7
250250702003	Downtown	2,625	647	54.9	54.9
250250703001	Downtown	1,065	804	53.5	53.2
250250703002	Downtown	733	449	54.3	54.2
250250501011	Eagle Hill East	1,713	534	62.3	62.8
250250501012	Eagle Hill East	1,472	632	60.8	60.2
250250501013	Eagle Hill East	1,930	684	61.8	61.7
250250502001	Eagle Hill East	2,189	757	60.6	60.7
250250502002	Eagle Hill East	1,151	445	60.2	60.0
250250502003	Eagle Hill East	836	283	63.9	63.9
250250502004	Eagle Hill East	1,055	349	64.3	64.2
250250507001	Eagle Hill East	1,684	617	60.2	60.5
250250507002	Eagle Hill East	1,344	484	62.2	62.1
250250507003	Eagle Hill East	1,476	505	63.6	63.6
250250509011	Eagle Hill East	1,283	420	68.0	69.0
250250509012	Eagle Hill East	1,964	717	65.5	64.9
250250509013	Eagle Hill East	918	309	65.1	66.5
250250503001	East Boston	727	282	57.9	57.2
250250503002	East Boston	1,524	759	57.0	56.6
250250504001	East Boston	637	237	57.9	57.9
250250504002	East Boston	1,735	797	58.5	58.6
250250505001	East Boston	1,857	702	60.4	60.2
250250506001	East Boston	1,248	494	59.3	59.4
250250506002	East Boston	815	312	58.6	58.9
250250507001	East Boston	1,684	617	60.2	60.5
250250510001	East Boston	2,039	855	64.9	64.8
250250510002	East Boston	962	462	60.8	58.8
250250510003	East Boston	1,088	467	64.3	63.9
250250511013	East Boston	1,537	621	61.7	61.5
250259813002	East Boston	389	244	61.4	77.2
250173421011	Everett	1,483	567	51.5	51.7

Table H-26 2017 DNL Levels for Census Block Group Locations within DNL 50 dB (Continued)

U.S. Census 2010 Block Group

Block Group ID	Name	Population	Housing units	Average Block DNL	DNL at centroid
250173421012	Everett	1,067	389	52.0	52.2
250173421014	Everett	943	362	51.7	51.6
250173421024	Everett	1,252	452	50.0	50.2
250173422011	Everett	2,830	1,066	51.2	51.1
250173422012	Everett	2,438	996	51.9	51.9
250173423001	Everett	1,327	495	53.9	53.7
250173423002	Everett	1,555	596	54.7	54.7
250173423003	Everett	2,137	858	56.9	56.9
250173423004	Everett	1,807	805	55.5	55.8
250173424001	Everett	1,878	847	58.9	58.8
250173424002	Everett	1,132	480	59.3	59.7
250173424003	Everett	905	346	59.4	58.7
250173424004	Everett	1,348	517	59.9	60.1
250173424005	Everett	792	363	55.7	55.5
250173425001	Everett	2,428	941	52.5	52.7
250173425002	Everett	2,169	870	55.4	55.2
250173425003	Everett	2,200	970	58.1	58.0
250173426001	Everett	1,125	395	54.2	54.2
250173426002	Everett	904	347	55.9	56.2
250173426003	Everett	2,336	941	55.2	55.2
250235011011	Hingham	1,218	483	49.4	50.4
250235001011	Hull	1,502	828	55.7	56.2
250235001012	Hull	819	452	52.3	52.2
250235001013	Hull	1,381	726	51.0	52.0
250235001041	Hull	1,207	626	50.7	55.2
250235001042	Hull	919	488	51.8	55.1
250235001043	Hull	792	470	51.2	51.8
250235001044	Hull	1,464	731	50.7	50.6
250251404007	Hyde Park	1,172	463	50.3	50.3
250250812001	Jamaica Plain	2,130	813	50.3	50.3
250250814003	Jamaica Plain	1,164	548	51.0	51.2
250251201041	Jamaica Plain	516	252	51.4	51.0
250251201042	Jamaica Plain	799	351	50.9	50.9
250251201043	Jamaica Plain	780	457	50.3	50.2
250251202011	Jamaica Plain	1,147	611	51.9	51.9
250251202012	Jamaica Plain	1,841	894	53.0	53.0

Table H-26 2017 DNL Levels for Census Block Group Locations within DNL 50 dB (Continued)

U.S. Census 2010 Block Group					
Block Group ID	**Name**	**Population**	**Housing units**	**Average Block DNL**	**DNL at centroid**
250251202013	Jamaica Plain	451	221	52.9	52.9
250251203013	Jamaica Plain	1,543	554	53.5	53.7
250251204001	Jamaica Plain	856	424	51.5	51.5
250251204002	Jamaica Plain	676	363	51.6	51.7
250251204003	Jamaica Plain	895	466	50.9	51.0
250251204004	Jamaica Plain	1,862	845	50.1	50.1
250251205001	Jamaica Plain	824	334	51.1	51.1
250251205002	Jamaica Plain	733	270	50.0	50.0
250251205002	Jamaica Plain	733	270	50.0	50.0
250251205003	Jamaica Plain	774	301	50.6	50.5
250259810001	Jamaica Plain	22	5	51.0	50.8
250250512001	Jefferies Point	32	19	61.6	60.1
250250512002	Jefferies Point	1,548	692	60.7	60.4
250250512003	Jefferies Point	799	449	59.5	59.6
250092051001	Lynn	1,192	534	51.0	51.0
250092051002	Lynn	1,077	413	51.6	51.7
250092051003	Lynn	919	361	53.5	53.7
250092051004	Lynn	1,527	556	53.5	53.9
250092051005	Lynn	637	264	54.3	54.5
250092052001	Lynn	806	410	52.3	52.7
250092052002	Lynn	714	277	54.5	54.8
250092052003	Lynn	1,510	564	54.4	54.4
250092052004	Lynn	1,435	511	55.2	55.4
250092052005	Lynn	854	385	52.1	52.9
250092055001	Lynn	2,054	736	51.7	50.8
250092055002	Lynn	2,552	961	56.0	55.9
250092058001	Lynn	1,044	362	51.2	51.7
250092058002	Lynn	1,089	342	51.9	52.0
250092059001	Lynn	1,743	598	51.6	51.7
250092059002	Lynn	1,262	443	50.8	50.7
250092060001	Lynn	1,443	478	55.5	55.7
250092060002	Lynn	1,916	642	54.1	54.5
250092061001	Lynn	1,793	797	55.7	56.0
250092061002	Lynn	2,051	665	56.4	56.6
250092062001	Lynn	1,128	327	53.9	54.0
250092062002	Lynn	2,267	786	55.6	55.8

Table H-26	2017 DNL Levels for Census Block Group Locations within DNL 50 dB (Continued)				
U.S. Census 2010 Block Group					
Block Group ID	**Name**	**Population**	**Housing units**	**Average Block DNL**	**DNL at centroid**
250092062003	Lynn	1,859	573	54.4	54.4
250092063001	Lynn	712	250	51.5	52.1
250092063003	Lynn	1,030	379	50.8	50.8
250092063004	Lynn	1,040	367	52.9	53.0
250092068001	Lynn	1,754	685	50.5	50.4
250092068002	Lynn	1,792	914	52.3	52.3
250092070001	Lynn	963	585	55.5	53.4
250092070002	Lynn	1,235	456	56.7	57.0
250092071001	Lynn	1,446	444	55.0	55.4
250092071002	Lynn	992	307	56.5	56.6
250092071003	Lynn	1,075	342	53.9	54.0
250092072001	Lynn	1,212	391	56.0	58.1
250092072002	Lynn	1,727	789	56.9	57.2
250173411021	Malden	1,346	726	50.3	50.3
250173411024	Malden	557	336	53.1	52.7
250173412001	Malden	1,164	491	52.2	51.6
250173412002	Malden	976	386	53.8	54.0
250173412003	Malden	1,070	451	56.0	56.3
250173412004	Malden	978	383	55.8	55.9
250173412005	Malden	1,693	713	54.8	55.0
250173412006	Malden	976	362	54.0	54.0
250173413002	Malden	922	482	50.7	51.1
250173414001	Malden	1,085	417	50.4	50.3
250173414002	Malden	944	340	51.0	50.9
250173414003	Malden	1,802	702	51.7	51.8
250173414004	Malden	1,612	603	52.6	52.6
250173414005	Malden	769	389	54.7	55.9
250250924004	Mattapan	1,142	413	52.0	52.1
250250924005	Mattapan	721	276	51.9	51.9
250251001001	Mattapan	167	61	51.3	51.6
250251001004	Mattapan	964	298	50.7	50.7
250251001005	Mattapan	622	243	50.1	50.0
250251001006	Mattapan	1,320	492	50.6	50.4
250251011011	Mattapan	775	276	50.3	50.2
250259811002	Mattapan	12	2	49.9	50.2
250259811004	Mattapan	400	128	51.8	51.8

Table H-26	2017 DNL Levels for Census Block Group Locations within DNL 50 dB (Continued)				
U.S. Census 2010 Block Group					
Block Group ID	**Name**	**Population**	**Housing units**	**Average Block DNL**	**DNL at centroid**
250173391001	Medford	617	243	51.2	53.4
250173391002	Medford	1,460	603	53.7	53.7
250173391003	Medford	1,169	691	53.9	54.1
250173391004	Medford	1,797	1,041	52.9	53.1
250173391005	Medford	1,399	446	51.9	52.2
250173392004	Medford	1,449	540	50.6	50.7
250173394001	Medford	1,033	529	51.7	51.6
250173394002	Medford	626	251	52.2	52.2
250173394004	Medford	882	420	51.6	51.4
250173395001	Medford	2,710	553	53.1	53.5
250173395002	Medford	1,312	547	54.2	54.3
250173395003	Medford	641	283	53.0	52.9
250173395004	Medford	736	307	53.1	53.1
250173396001	Medford	797	392	54.5	54.3
250173396002	Medford	813	371	54.6	54.6
250173396003	Medford	757	369	54.2	54.3
250173396004	Medford	827	363	54.1	54.2
250173396005	Medford	885	377	53.7	53.7
250173396006	Medford	945	443	53.3	53.4
250173397001	Medford	552	280	55.1	55.9
250173397002	Medford	1,678	670	54.8	55.0
250173397003	Medford	785	357	55.3	55.3
250173397004	Medford	863	377	54.2	54.2
250173398011	Medford	2,101	1,369	58.2	58.6
250173398012	Medford	617	263	57.9	57.9
250173398013	Medford	808	375	57.9	58.0
250173398014	Medford	884	363	57.2	57.2
250173398021	Medford	1,308	586	57.1	57.4
250173398022	Medford	2,498	1,096	56.4	57.0
250173398023	Medford	751	294	55.6	55.6
250173399001	Medford	1,651	719	55.9	56.2
250173399002	Medford	950	380	55.7	55.6
250173399003	Medford	939	425	55.2	55.2
250173399004	Medford	759	346	55.1	55.1
250173399005	Medford	872	342	55.0	55.0
250173400001	Medford	1,033	435	54.7	54.7
250173400002	Medford	848	376	54.3	54.3

Table H-26 2017 DNL Levels for Census Block Group Locations within DNL 50 dB (Continued)

U.S. Census 2010 Block Group					
Block Group ID	**Name**	**Population**	**Housing units**	**Average Block DNL**	**DNL at centroid**
250173400003	Medford	713	303	54.7	54.7
250173401002	Medford	1,047	389	51.1	51.2
250173401003	Medford	1,611	504	52.8	52.7
250173401004	Medford	1,483	609	54.4	54.5
250173401005	Medford	925	400	51.2	51.5
250173401006	Medford	826	310	53.7	53.9
250173412006	Medford	976	362	54.0	54.0
250214161011	Milton	771	280	51.9	51.8
250214161012	Milton	1,969	732	53.0	53.5
250214161013	Milton	1,818	663	50.1	50.8
250214164001	Milton	789	302	51.5	54.7
250214164005	Milton	1,028	348	53.3	54.1
250214164006	Milton	978	357	51.9	53.8
250214164007	Milton	1,002	386	53.0	55.4
250250511011	Orient Heights	1,602	598	58.7	58.0
250250511012	Orient Heights	1,949	741	57.5	57.2
250250511013	Orient Heights	1,537	621	61.7	61.5
250250511014	Orient Heights	1,005	385	59.5	57.7
250092106003	Peabody	1,194	491	49.2	50.6
250092106004	Peabody	623	250	49.9	51.0
250214172001	Quincy	2,743	1,256	50.5	50.8
250214173001	Quincy	1,781	1,180	51.9	53.6
250214173002	Quincy	900	630	52.2	53.2
250251701002	Revere	1,012	384	50.1	50.1
250251701003	Revere	773	320	50.7	50.8
250251705011	Revere	1,934	1,112	53.4	53.9
250251705012	Revere	1,501	814	54.0	54.2
250251705021	Revere	1,134	550	58.5	58.9
250251705022	Revere	1,684	998	57.7	59.0
250251706012	Revere	1,413	573	51.0	51.5
250251706014	Revere	954	380	50.3	50.2
250251707011	Revere	788	431	54.6	55.3
250251707012	Revere	1,311	622	58.8	59.1
250251707021	Revere	1,146	352	52.7	52.6
250251707022	Revere	1,474	509	54.2	53.9
250251707023	Revere	1,658	547	51.5	51.5
250251707024	Revere	959	358	52.4	52.7

Table H-26 2017 DNL Levels for Census Block Group Locations within DNL 50 dB (Continued)

U.S. Census 2010 Block Group					
Block Group ID	**Name**	**Population**	**Housing units**	**Average Block DNL**	**DNL at centroid**
250251707025	Revere	1,391	553	54.9	54.6
250251708001	Revere	1,815	797	63.7	64.8
250251708002	Revere	1,359	577	62.7	64.8
250251708003	Revere	967	419	61.6	63.0
250251708004	Revere	977	424	62.4	60.6
250259815021	Revere	9	3	58.4	54.4
250251101031	Roslindale	568	325	53.2	53.0
250251101032	Roslindale	733	257	51.8	51.8
250251101033	Roslindale	653	241	52.1	52.0
250251101034	Roslindale	620	289	52.4	52.4
250251101035	Roslindale	1,440	666	52.7	52.6
250251101036	Roslindale	583	271	52.5	52.6
250251101037	Roslindale	863	304	52.1	52.1
250251102011	Roslindale	2,051	874	51.3	51.4
250251103011	Roslindale	1,134	403	52.0	52.0
250251103012	Roslindale	1,271	552	52.4	52.5
250251104011	Roslindale	2,011	733	52.0	52.0
250251104012	Roslindale	1,555	629	51.9	51.9
250251104031	Roslindale	905	426	51.3	51.2
250251104032	Roslindale	783	314	51.4	51.5
250251104033	Roslindale	657	258	50.6	50.7
250251104034	Roslindale	975	377	51.2	51.3
250251104035	Roslindale	989	392	50.6	50.7
250251105011	Roslindale	849	367	50.6	50.5
250251105012	Roslindale	1,498	631	50.6	50.6
250251105013	Roslindale	906	373	50.0	50.0
250251105021	Roslindale	1,311	589	51.1	51.1
250251105022	Roslindale	1,855	810	51.3	51.4
250251105023	Roslindale	640	285	50.9	50.9
250251106071	Roslindale	1,013	519	50.1	50.1
250251106073	Roslindale	1,586	734	51.0	51.1
250251106074	Roslindale	949	273	50.1	50.0
250251401061	Roslindale	1,395	660	50.4	50.4
250251401062	Roslindale	506	238	50.7	50.7
250259803001	Roslindale	338	2	53.8	54.0
250259810001	Roslindale	22	5	51.0	50.8

Table H-26 2017 DNL Levels for Census Block Group Locations within DNL 50 dB (Continued)

U.S. Census 2010 Block Group					
Block Group ID	**Name**	**Population**	**Housing units**	**Average Block DNL**	**DNL at centroid**
250259811003	Roslindale	6	5	52.9	53.2
250250801001	Roxbury	2,612	450	56.9	57.3
250250801002	Roxbury	738	294	56.5	56.5
250250803001	Roxbury	1,769	791	56.1	56.1
250250804011	Roxbury	1,265	526	55.3	55.5
250250804012	Roxbury	1,445	723	53.6	53.7
250250806012	Roxbury	600	220	52.4	52.2
250250806013	Roxbury	459	242	53.5	53.7
250250813001	Roxbury	1,661	806	54.0	54.0
250250813002	Roxbury	1,749	690	52.6	52.7
250250813003	Roxbury	1,350	615	52.4	52.0
250250814001	Roxbury	1,067	558	53.1	53.3
250250814002	Roxbury	772	355	51.7	51.8
250250814003	Roxbury	1,164	548	51.0	51.2
250250815001	Roxbury	788	351	53.5	53.4
250250815002	Roxbury	1,346	554	54.2	54.2
250250817001	Roxbury	619	225	55.5	55.7
250250817002	Roxbury	893	430	55.6	55.7
250250817003	Roxbury	780	291	54.9	54.9
250250817004	Roxbury	887	355	54.9	54.9
250250817005	Roxbury	641	298	54.8	54.8
250250818001	Roxbury	1,157	577	56.0	56.0
250250818002	Roxbury	921	442	56.1	56.1
250250818003	Roxbury	820	369	55.7	55.7
250250819001	Roxbury	906	453	55.3	55.4
250250819002	Roxbury	617	259	54.9	55.1
250250819003	Roxbury	600	257	54.9	54.9
250250819004	Roxbury	992	428	54.8	54.8
250250820001	Roxbury	1,292	566	55.1	55.2
250250820002	Roxbury	682	298	55.2	55.2
250250820003	Roxbury	841	414	55.4	55.4
250250821001	Roxbury	1,228	526	54.7	54.8
250250821002	Roxbury	1,553	579	54.5	54.4
250250821003	Roxbury	2,244	1,012	55.0	55.0
250250901001	Roxbury	1,631	655	53.6	53.6
250250901002	Roxbury	531	237	52.7	52.7

Table H-26	2017 DNL Levels for Census Block Group Locations within DNL 50 dB (Continued)				
U.S. Census 2010 Block Group					
Block Group ID	**Name**	**Population**	**Housing units**	**Average Block DNL**	**DNL at centroid**
250250901003	Roxbury	693	303	52.8	52.8
250250901004	Roxbury	1,099	414	51.9	51.8
250250901005	Roxbury	617	249	51.3	51.4
250250902001	Roxbury	673	244	52.7	52.5
250250902002	Roxbury	626	278	53.0	53.4
250250902003	Roxbury	934	308	53.5	53.8
250250903001	Roxbury	891	333	53.8	53.6
250250903002	Roxbury	1,310	513	54.3	53.9
250250903003	Roxbury	978	422	54.6	54.7
250250904001	Roxbury	871	311	55.2	55.2
250250904002	Roxbury	1,155	435	55.0	55.0
250250904003	Roxbury	763	254	55.6	55.6
250250904004	Roxbury	870	294	56.0	56.0
250250906001	Roxbury	1,094	351	56.3	56.3
250250906002	Roxbury	1,254	442	56.3	56.4
250250913002	Roxbury	1,131	388	55.3	55.4
250250914002	Roxbury	1,069	355	54.5	54.4
250250924002	Roxbury	1,089	417	50.6	50.6
250250924003	Roxbury	1,688	711	51.8	51.7
250250924005	Roxbury	721	276	51.9	51.9
250251203011	Roxbury	1,166	443	52.6	52.4
250251203012	Roxbury	855	331	53.7	53.7
250251203013	Roxbury	1,543	554	53.5	53.7
250251203014	Roxbury	1,231	567	52.6	52.5
250259803001	Roxbury	338	2	53.8	54.0
250092047011	Salem	785	328	50.3	51.9
250092081021	Saugus	752	301	45.5	50.8
250173501032	Somerville	1,210	520	55.3	55.4
250173501041	Somerville	2,119	793	53.1	53.2
250173501042	Somerville	2,584	947	54.0	54.0
250173501043	Somerville	1,188	485	52.3	52.6
250173501044	Somerville	1,384	673	52.7	52.8
250173502001	Somerville	1,376	586	51.7	51.8
250173502002	Somerville	603	233	50.7	50.6
250173502003	Somerville	1,385	533	50.7	50.8
250173502004	Somerville	1,410	594	50.8	50.8

Table H-26	2017 DNL Levels for Census Block Group Locations within DNL 50 dB (Continued)				
U.S. Census 2010 Block Group					
Block Group ID	**Name**	**Population**	**Housing units**	**Average Block DNL**	**DNL at centroid**
250173502005	Somerville	749	315	51.6	51.6
250173502006	Somerville	1,044	502	51.9	51.9
250173503001	Somerville	965	454	52.3	51.8
250173503002	Somerville	627	304	51.6	51.7
250173503003	Somerville	849	390	52.6	52.6
250173504001	Somerville	1,006	368	53.7	53.9
250173504002	Somerville	1,232	565	52.9	52.9
250173504003	Somerville	1,017	462	52.2	52.2
250173504004	Somerville	1,464	721	52.6	52.7
250173504005	Somerville	849	392	53.3	53.3
250173505001	Somerville	818	390	53.0	53.1
250173505002	Somerville	811	382	53.0	53.0
250173506001	Somerville	1,656	2	53.5	53.5
250173506002	Somerville	939	371	53.0	53.0
250173506003	Somerville	813	231	52.7	52.8
250173506004	Somerville	1,164	487	53.3	53.3
250173507001	Somerville	907	602	51.0	50.7
250173507002	Somerville	974	390	51.6	51.5
250173507003	Somerville	1,007	461	52.1	52.3
250173507004	Somerville	1,375	760	51.9	51.8
250173507005	Somerville	861	460	52.2	52.3
250173507006	Somerville	924	443	52.5	52.5
250173508001	Somerville	971	485	52.6	52.6
250173508002	Somerville	857	435	52.6	52.7
250173509001	Somerville	803	398	51.8	51.9
250173509002	Somerville	1,209	535	51.1	51.2
250173509003	Somerville	1,302	715	52.1	52.2
250173510001	Somerville	1,236	595	50.5	50.6
250173510005	Somerville	1,056	484	51.1	51.2
250173511002	Somerville	912	465	50.3	50.4
250173514031	Somerville	763	309	51.9	51.9
250173514032	Somerville	1,017	391	51.1	51.0
250173514033	Somerville	587	321	51.2	51.2
250173514034	Somerville	1,042	369	51.0	51.0
250173514035	Somerville	619	288	51.0	51.0
250173514041	Somerville	1,147	448	50.1	50.1
250250601011	South Boston	881	441	60.8	60.9

Table H-26	2017 DNL Levels for Census Block Group Locations within DNL 50 dB (Continued)				
U.S. Census 2010 Block Group					
Block Group ID	**Name**	**Population**	**Housing units**	**Average Block DNL**	**DNL at centroid**
250250601012	South Boston	633	350	60.1	60.2
250250601013	South Boston	981	496	60.5	60.5
250250601014	South Boston	721	397	59.5	59.6
250250602001	South Boston	821	419	57.7	57.8
250250602002	South Boston	1,095	580	56.9	56.6
250250603011	South Boston	1,285	741	56.0	55.9
250250603012	South Boston	699	345	55.6	55.5
250250603013	South Boston	1,092	561	56.4	56.3
250250604001	South Boston	1,021	542	55.5	55.7
250250604002	South Boston	988	530	55.2	55.3
250250604003	South Boston	842	466	54.9	54.8
250250604004	South Boston	1,093	669	55.0	55.0
250250604005	South Boston	960	336	56.1	56.1
250250605011	South Boston	699	375	57.3	57.2
250250605012	South Boston	868	508	56.7	56.7
250250605013	South Boston	717	431	56.9	56.9
250250605014	South Boston	631	295	58.6	58.3
250250605015	South Boston	656	333	57.4	57.4
250250606001	South Boston	2,357	1,530	59.9	62.9
250250607001	South Boston	741	253	59.3	59.3
250250607002	South Boston	1,152	383	58.8	58.9
250250608001	South Boston	655	333	56.9	56.9
250250608002	South Boston	757	396	57.3	57.3
250250608003	South Boston	886	470	58.1	58.2
250250608004	South Boston	1,666	943	57.6	57.9
250250610001	South Boston	1,033	544	56.0	56.0
250250610002	South Boston	1,164	471	55.7	55.6
250250610003	South Boston	901	393	55.8	55.5
250250611011	South Boston	617	278	55.2	55.3
250250611012	South Boston	1,615	756	54.3	54.1
250250612001	South Boston	1,702	1,158	59.9	59.8
250250612002	South Boston	627	383	56.9	57.9
250250612003	South Boston	911	470	55.9	56.0
250250907004	South Boston	651	302	55.4	56.1
250259812021	South Boston	207	0	61.7	61.8
250250703003	South End	992	707	53.4	53.6
250250703004	South End	1,119	746	54.4	54.4

Table H-26 2017 DNL Levels for Census Block Group Locations within DNL 50 dB (Continued)

U.S. Census 2010 Block Group					
Block Group ID	**Name**	**Population**	**Housing units**	**Average Block DNL**	**DNL at centroid**
250250704021	South End	1,723	680	55.9	56.8
250250705001	South End	1,700	1,018	55.9	55.9
250250705002	South End	999	524	54.9	55.0
250250705003	South End	1,393	803	55.4	55.4
250250705004	South End	1,368	721	54.8	54.8
250250706001	South End	1,127	667	54.1	54.0
250250706002	South End	1,113	642	53.5	53.4
250250707001	South End	1,161	644	52.7	52.7
250250707002	South End	1,200	722	52.7	52.7
250250708001	South End	1,594	965	52.9	53.0
250250708002	South End	1,040	579	52.3	52.3
250250708003	South End	1,072	612	52.1	52.1
250250709001	South End	2,166	1,231	54.4	54.3
250250709002	South End	1,163	567	53.9	54.0
250250711011	South End	1,498	928	56.6	56.6
250250711012	South End	1,424	750	55.9	56.6
250250711013	South End	831	507	55.8	56.0
250250712011	South End	1,899	819	57.3	57.6
250250712012	South End	1,232	578	56.7	56.9
250250804011	South End	1,265	526	55.3	55.5
250250805001	South End	1,076	460	52.8	52.9
250250805002	South End	2,020	863	53.7	53.9
250250806011	South End	3,212	458	52.1	51.6
250251303001	West Roxbury	848	342	50.1	50.1
250173381002	Winchester	1,534	569	50.3	50.2
250173385001	Winchester	1,433	494	50.5	51.9
250173385004	Winchester	1,350	600	50.7	50.8
250251801011	Winthrop	1,207	584	53.4	53.1
250251801012	Winthrop	1,215	724	51.7	51.8
250251801013	Winthrop	2,344	1,194	54.1	54.4
250251802001	Winthrop	1,471	610	58.2	58.4
250251802002	Winthrop	647	299	56.9	56.9
250251802003	Winthrop	648	336	58.5	58.6
250251802004	Winthrop	1,343	549	59.9	61.4
250251803011	Winthrop	652	258	60.0	59.9
250251803012	Winthrop	778	322	61.7	61.8
250251803013	Winthrop	834	351	61.3	61.5

Table H-26 2017 DNL Levels for Census Block Group Locations within DNL 50 dB (Continued)

U.S. Census 2010 Block Group					
Block Group ID	**Name**	**Population**	**Housing units**	**Average Block DNL**	**DNL at centroid**
250251803014	Winthrop	760	297	62.6	63.3
250251804001	Winthrop	876	435	57.8	57.3
250251804002	Winthrop	839	347	58.8	58.7
250251805001	Winthrop	1,273	613	55.7	55.4
250251805002	Winthrop	572	271	64.5	66.7
250251805003	Winthrop	1,156	671	59.6	59.6
250251805004	Winthrop	882	459	66.1	66.0
250251805004	Winthrop	882	459	66.1	66.0

Source: HMMH, 2019.

Massport and FAA Correspondence Letters

This section provides copies of correspondence between Massport and FAA regarding flight procedures and the RNAV Pilot Project.

Massport and FAA correspondence letter regarding RNAV Pilot Test: Request that FAA adopt the jetBlue Airways RNAV Visual Approach Procedure to Runway 33L dated April 7, 2017.

massport
Massachusetts Port Authority
One Harborside Drive
East Boston, MA 02128-2909
Telephone (617) 568-5000
www.massport.com

April 7, 2017

Todd Friedenberg
Deputy Regional Administrator
Federal Aviation Administration
New England Region
1200 District Avenue
Burlington, MA 01803-5299

Re: FAA\MPA RNAV Pilot Test: Request that FAA adopt the jetBlue RNAV Visual Approach Procedure to Boston Logan Runway 33L

Dear Mr. Friedenberg:

As a follow up to our ongoing work on the joint Massport and FAA RNAV Pilot Test, I'm writing to request that the FAA adopt and refine for public use the existing jetBlue Airways (jetBlue) RNAV Visual to Boston Logan's Runway R33L. We believe that by making this procedure more readily available to all national airspace users, there will be an increase in the utilization of the RNAV Visual to R33L during the late night period, providing greater noise abatement benefits to communities near Boston Logan.

Recall that one outcome of the Boston Logan Overflight Noise Study was the design of a noise abatement approach to R33L that avoids the Town of Hull and other South Shore communities by taking advantage of overflying Boston Harbor during the late night time period. Consistent with this goal, in November 2014, jetBlue published a RNAV Visual procedure and agreed to make this "public" and therefore available to the broader Boston Logan air carrier community.

Massport has been working with the FAA's NextGen Eastern Branch to advocate and encourage air carriers to adopt the JetBlue RNAV Visual procedure. However, the most recent data (March 2017) from Massport shows that only about 26% of R33L jet arrivals from midnight to 5AM took advantage of this noise reduction procedure. We believe that if the FAA adopts this procedure the utilization rate of the RNAV Visual to R33L will increased when demand and weather allow.

Please feel free to contact me with any further questions.

Sincerely,

Flavio Leo
Director, Aviation Planning and Strategy
Massachusetts Port Authority

Cc: Amy Corbett (FAA), Ed Freni (Massport)

Massport and FAA correspondence letter regarding Massport recommended procedural changes to RNAV dated December 20, 2017.

massport
Massachusetts Port Authority
One Harborside Drive
East Boston, MA 02128-2909
Telephone (617) 568-5000
www.massport.com

December 20, 2017

Ms. Amy Corbett
Regional Administrator
Federal Aviation Administration
New England Region
1200 District Avenue
Burlington, MA 01803-5299

RE: FAA\MPA RNAV MOU Block 1 Ideas: Request for FAA Review and Implementation for Boston Logan International Airport

Dear Ms. Corbett: Amy

I am writing to request that the Federal Aviation Administration (FAA) review and implement the Block 1 procedure recommendations by the Massachusetts Institute of Technology (MIT) study team as a result of the Memorandum of Understanding (MOU) between the FAA and the Massachusetts Port Authority (Massport). The MOU, executed in September 2016, commits the FAA and Massport to undertake a unique, pilot testing of ideas to reduce noise from the FAA's implementation of Precision Based Navigation (PBN) procedures including RNAV at Boston Logan International Airport (Boston Logan).

Consistent with the MOU, the testing of ideas has involved a technical team of FAA and Massport staff, supported by subject matter experts lead by MIT's International Center for Air Transportation. The work included extensive public outreach, feedback through public hearings, and briefings to and feedback from the Massport Community Advisory Committee (MCAC) and local, state and federal elected officials.

After an initial investigation, the MIT team proposed segregating ideas to be evaluated into two blocks. Block 1 ideas would provide noise benefits while not generating major equity issues (moving noise from one community to another) and would have minimal operational/ technical implementation barriers. Block 2 ideas would result in shifting of noise, or would have substantial technical hurdles and, therefore, require further analysis and review.

MIT has completed its work on Block 1 and issued its final report "Block 1 Procedure Recommendations for Logan Airport Community Noise Reduction" to Massport and the FAA. MIT's technical feasibility analysis of Block 1 includes an examination of flight safety, aircraft performance, navigation and flight management systems (FMS) limitations, pilot workload, Air Traffic Control workload, and procedure design criteria. Representatives from MIT, Massport and the FAA have briefed the public and the MCAC throughout the process, and feasible feedback from the public has been included into MIT's recommendations. On December 7, 2017, the MCAC voted to support and recommend implementation of the Block 1 procedures.

The table below from the MIT report summarizes MIT's recommendations and highlights the primary benefits.

Block 1 Procedure Recommendations

Proc. ID D = Dep. A = Arr.	Procedure	Primary Benefits
1-D1	Restrict target climb speed for jet departures from Runways 33L and 27 to 220 knots or minimum safe airspeed in clean configuration, whichever is higher.	Reduced airframe and total noise during climb below 10,000 ft (beyond immediate airport vicinity)
1-D2	Modify RNAV SID from Runway 15R to move tracks further to the north away from populated areas.	Departure flight paths moved north away from Hull
1-D3	Modify RNAV SID from Runway 22L and 22R to initiate turns sooner after takeoff and move tracks further to the north away from populated areas.	Departure flight paths moved north away from Hull and South Boston
1-D3a	*Option A*: Climb to intercept course (VI-CF) procedure	
1-D3b	*Option B*: Climb to altitude, then direct (VA-DF) procedure	
1-D3c	*Option C*: Heading-based procedure	
1-A1	Implement an overwater RNAV approach procedure with RNP overlay to Runway 33L that follows the ground track of the jetBlue RNAV Visual procedure as closely as possible.	Arrival flight paths moved overwater instead of over the Hull peninsula and points further south
1-A1a	*Option A*: Published instrument approach procedure	
1-A1b	*Option B*: Public distribution of RNAV Visual procedure	

Source: MIT

We understand that the FAA will also need to undertake its own internal review including safety, operational feasibility and environmental impacts. It is our hope that the FAA will be able to adopt these recommendations as expeditiously as possible.

On behalf of Massport, I want to thank the FAA for its commitment to this very important and unique initiative. Please feel free to contact me directly or Flavio Leo, Director of Aviation Planning and Strategy, with any further questions.

Sincerely,

Edward C. Freni
Director of Aviation

cc: Todd Friedenberg (FAA), David Carlon (MCAC), Tom Glynn (Massport), John Hansman (MIT), Liz Becker (Massport), Flavio Leo (Massport)

FAA June 2018 update letter regarding RNAV Pilot Test: Request that FAA adopt the jetBlue Airways RNAV Visual Approach Procedure to Runway 33L dated June 8, 2018.

U.S. Department of Transportation
Federal Aviation Administration

Office of the Regional Administrator
New England Region

1200 District Avenue
Burlington, MA 01803

June 8, 2018

David Carlon
Chairman
Massport Community Advisory Committee
P.O. Box 470614
Brookline, MA 02447

Dear Mr. Carlon:

In a letter dated April 7, 2017, the Massachusetts Port Authority (Massport) requested the Federal Aviation Administration (FAA) modify and adopt the existing JetBlue Airways (JBU) Area Navigation (RNAV) visual approach to Boston-Logan International Airport's (Boston-Logan) Runway 33Left (RWY 33L) for public use. Massport indicated modifying the procedure would likely result in increased nighttime use, and subsequently provide greater noise abatement benefits to communities near Boston-Logan.

Based on Massport's formal request, the FAA began developing this new procedure, which is virtually identical to the current JBU Special RNAV Visual Flight Procedure (RVFP) to RWY 33L that has been in use since 2009. Slight variations were made to ensure flyability and adherence to safety criteria for larger jet aircraft. However, representatives from the aircraft operator/pilot community advised the FAA of a potential risk to implementation that will cause the procedure to miss the anticipated July publication date.

We are reviewing flight data, and have requested additional simulation testing. We notified Massport of the issue, and the FAA will continue to cooperate with Massport in analyzing the data fully. The FAA intends to reschedule publication for September 13, 2018, which is the next date in the 56-day charting cycle. However, publication may be delayed further as simulation testing occurs and risks are better understood, or may even be canceled if the risks cannot be mitigated.

We will keep the Massport CAC updated as changes occur. In the interim, if my office can be of further assistance, please contact Julie Seltsam-Wilps of the Regional Administrator's staff at 781-238-7389.

Sincerely,

Kerry B. Long

Kerry B. Long
Acting Regional Administrator

This Page Intentionally Left Blank.

I

Air Quality/Emissions Reduction

This appendix provides the following detailed information and data tables in support of Chapter 7, *Air Quality/Emissions Reduction*:

- Fundamentals of Air Quality
  - Table I-1 National Ambient Air Quality Standards (NAAQS)
  - Table I-2 Airport-Related Sources of Air Emissions
  - Table I-3 Attainment, Nonattainment, and Maintenance Areas
- Aircraft Fleet and Operational Data Used in AEDT 2d
  - Table I-4 2017 Fleet Mix, Annual Landing and Takeoff Cycles (LTOs), and Taxi/Delay Time-in-Mode by Aircraft Type
  - Table I-5 Future Planning Horizon Fleet Mix, Annual Landing and Takeoff Cycles (LTOs), and Taxi/Delay Time-in-Mode (TIM) by Aircraft Type
- Ground Service Equipment (GSE) Time-in-Mode (TIM) Survey
  - Table I-6 Ground Service Equipment (GSE) Time-in-Mode (TIM) (minutes)
- Ground Service Equipment (GSE)/Alternative Fuels Conversion
  - Table I-7 Ground Service Equipment (GSE) Alternative Fuel Conversion Summary (kg/day)
- Motor Vehicle Emissions
  - Table I-8 MOVES2014b Sample Input File for 2017
  - Table I-9 MOVES2014b Sample Output File for 2017
  - Table I-10 MOVES2014b Sample Input File for the Future Planning Horizon
  - Table I-11 MOVES2014b Sample Output File for the Future Planning Horizon
- Fuel Storage and Handling
  - Table I-12 Fuel Throughput by Fuel Category (gallons)

Fundamentals of Air Quality

This section contains a general summary of air quality and air emissions with a particular emphasis on airport-related emissions where appropriate. This material is intended to supplement and provide background information for the materials contained in Chapter 7, *Air Quality/Emissions Reduction*.

Pollutant Types and Standards

The U.S. Environmental Protection Agency (EPA) has established National Ambient Air Quality Standards (NAAQS) for a select group of "criteria air pollutants" designed to protect public health, the environment, and the quality of life from the detrimental effects of air pollution. Listed alphabetically, these pollutants are briefly described below:

- **Carbon monoxide (CO)** is a colorless, odorless, tasteless gas. It may temporarily accumulate, especially in cool, calm weather conditions, when fuel use reaches a peak and CO is chemically most stable due to the low temperatures. CO from natural sources usually dissipates quickly, posing no threat to human health. Transportation sources (e.g., motor vehicles), energy generation, and open burning are among the predominant anthropogenic (i.e., man-made) sources of CO.

- **Lead (Pb)** in the atmosphere is generated from industrial sources including waste oil and solid waste incineration, iron and steel production, lead smelting, and battery and lead manufacturing. The lead content of motor vehicle emissions, which was the major source of lead in the past, has significantly declined with the widespread use of unleaded fuel. Low-lead fuel used in some general aviation (GA) aircraft is still a source of airport-related lead.

- **Nitrogen dioxide (NO_2)**, nitric oxide (NO), and the nitrate radical (NO_3) are collectively called oxides of nitrogen (NO_x). These three compounds are interrelated, often changing from one form to another in chemical reactions, and NO_2 is the compound commonly measured for comparison to the NAAQS. NO_x is generally emitted as NO, which is oxidized to NO_2. The principal man-made source of NO_x is fuel combustion in motor vehicles and power plants – aircraft engines are also a source. Reactions of NO_x with other atmospheric chemicals can lead to formation of ozone (O_3) and acidic precipitation.

- **Ozone (O_3)** is a secondary pollutant, formed from daytime reactions of NO_x and volatile organic compounds (VOCs) in the presence of sunlight. VOCs, which are a subset of hydrocarbons (HC) and have no NAAQS, are released in industrial processes and from evaporation of gasoline and solvents. Sources of NO_x are discussed above.

- **Particulate matter (PM)** comprises very small particles of dirt, dust, soot, or liquid droplets called aerosols. The NAAQS for PM is segregated by sizes (i.e., less than 10 and less than 2.5 microns as PM_{10} and $PM_{2.5}$, respectively). PM is formed as an exhaust product in the internal combustion engine or can be generated from the breakdown and dispersion of other solid materials (e.g., fugitive dust).

- **Sulfur oxides (SO_x)** are primarily composed of sulfur dioxide (SO_2) which is emitted in natural processes and by man-made sources such as combustion of sulfur-containing fuels and sulfuric acid manufacturing.

The NAAQS for these criteria pollutants are subdivided into the Primary Standards (designed to protect human health) and the Secondary Standards (designed to protect the environment and human welfare) and are listed below in **Table I-1**. Exceedances of these values constitute violations of the NAAQS.

Table I-1 National Ambient Air Quality Standards

Pollutant	Primary/ Secondary	Averaging Time	Standard ppm	Standard μg/m³	Form
Carbon Monoxide (CO)	Primary	1 hour	35	40,000	Not to be exceeded more than once a year.
		8-hour	9	10,000	Not to be exceeded more than once a year.
Lead (Pb)	Primary and Secondary	Rolling 3-Month Average	—	0.15	Not to exceed this level. Final rule October 2008.
Nitrogen Dioxide (NO_2)	Primary	1 hour	0.100	188	The 3-year average of the 98th percentile of the daily maximum 1-hour average at each monitor within an area must not exceed 0.100 ppm.
	Primary and Secondary	Annual	0.053	100	Not to exceed this level.
Ozone (O_3)	Primary and Secondary	8-hour[1]	0.070	—	Annual fourth-highest daily maximum 8-hour concentration, average over 3 years.
Particulate Matter with a diameter ≤10μm (PM_{10})	Primary and Secondary	24-hour	—	150	Not to be exceeded more than once a year on average over 3 years.
Particulate Matter with a diameter ≤2.5μm ($PM_{2.5}$)	Primary and Secondary	24-hour	—	35	The 3-year average of the 98th percentile for each population-oriented monitor within an area is not to exceed this level.
	Primary	Annual	—	12	The 3-year average of the weighted annual mean from single or multiple monitors within an area is not to exceed this level.
	Secondary	Annual	—	15	The 3-year average of the weighted annual mean from single or multiple monitors within an area is not to exceed this level.
Sulfur Dioxide (SO2)	Primary	1 hour	0.075	196	Final rule signed June 2, 2010. The 3-year average of the 99th percentile of the daily maximum 1-hour average at each monitor within an area must not exceed this level.
	Secondary	3-hour	0.5	1,300	Not to be exceeded more than once a year.

Source: EPA, 2019 (https://www.epa.gov/criteria-air-pollutants).
Note: There is no NAAQS standard for NO_x. μg/m³ - micrograms per cubic meter; ppm - parts per million.
1 Final rule signed October 1, 2015, and effective December 28, 2015. The previous (2008) O_3 standard additionally remains in effect in some areas. Revocation of the 2008 standard and transitioning to the new standard will be achieved over the next three years.

Sources of Airport Air Emissions

Almost all large metropolitan airports generate air emissions from the following general source categories: aircraft, ground service equipment (GSE), and motor vehicles traveling to, from, and moving about the airport; fuel storage and transfer facilities; a variety of stationary sources (e.g., steam boilers, back-up generators, snow melters, etc.); an assortment of aircraft maintenance activities (e.g., painting, cleaning, repair, etc.); routine airfield, roadway, and building maintenance activities (e.g., painting, cleaning, repair, etc.); and periodic construction activities for new projects or improvements to existing facilities. **Table I-2** provides a summary listing of these sources of air emissions, the pollutants, and their characteristics.

Table I-2 Airport-related Sources of Air Emissions

Sources	Emissions	Characteristics
Aircraft	CO NO_2 PM SO_2 VOCs	Exhaust products of fuel combustion that vary depending on aircraft engine type, number of engines, power setting, and period of operation. Emissions are also emitted by an aircraft's auxiliary power unit (APU).
Motor vehicles	CO NO_2 PM SO_2 VOCs	Exhaust products of fuel combustion from patron and employee traffic approaching, departing, and moving about the airport site. Emissions vary depending on vehicle type, distance traveled, operating speed, and ambient conditions.
Ground service equipment (GSE)	CO NO_2 PM SO_2 VOCs	Exhaust products of fuel combustion from service trucks, tow tugs, belt loaders, and other portable equipment.
Fuel storage and transfer	VOCs	Formed from the evaporation and vapor displacement of fuel from storage tanks and fuel transfer facilities. Emissions vary with fuel usage, type of storage tank, refueling method, fuel type, vapor recovery, climate, and ambient temperature.
Stationary sources	CO NO_2 PM SO_2 VOCs	Exhaust products of fossil fuel combustion from boilers dedicated to indoor heating requirements and emissions from incinerators used for waste reduction. Emissions are generally well controlled with operational techniques and post-burn collection methods. Sources include boilers and hot water generators, emergency generators, incinerators, paint booth and surface coating operations, welding operations, and firefighting facilities.

Table I-2 Airport-related Sources of Air Emissions (Continued)

Sources	Emissions	Characteristics
Construction Activities	CO NO_2 PM SO_2 VOCs	Construction projects may have associated emissions from dust generated during excavation and land clearing, exhaust emissions from construction equipment and motor vehicles, and evaporative emissions from asphalt paving and painting. The amount of particulate emissions varies with the material type, the amount of area exposed, and meteorology. The construction of airport and airfield improvement projects at airports represents temporary sources of emissions.

Source: KBE, 2019.
Notes: CO - carbon monoxide; NO_2 - nitrogen dioxide; PM - particulate matter; and SO_2 - sulfur dioxide; VOC - volatile organic compounds.

EPA, state, and local air quality agencies maintain outdoor air monitoring networks to measure air quality conditions and gauge compliance with the NAAQS. Based upon the data collected by these agencies, all areas throughout the country are designated by EPA with respect to their compliance with the NAAQS. **Table I-3** provides the definitions of each of these designations.

Table I-3 Attainment, Nonattainment, and Maintenance Areas

Attainment/Nonattainment Designations			
Attainment	**Attainment/Maintenance**	**Nonattainment Area**	**Unclassifiable**
Any area that meets the National Ambient Air Quality Standards (NAAQS) established for all of the criteria air pollutants.	Any area that is in transition from formerly being a nonattainment area to an Attainment area (also called Maintenance).	Any area that does not meet (or that contributes to ambient air quality in a nearby area that does not meet) one or more of the NAAQS.	Any area that cannot be classified on the basis of available information as meeting or not meeting the NAAQS.

Source: EPA, https://www.epa.gov/green-book, 2019.

For O_3, CO, PM_{10}, and $PM_{2.5}$, the Nonattainment designations are further classified by the severity, or degree, of the violation of the NAAQS. For example, in the case of O_3, these classifications range from highest to lowest as extreme, severe, serious, marginal, and moderate.

The Nonattainment designation of an area has a bearing on the emission control measures required and the time periods allotted by which a State Implementation Plan (SIP) must demonstrate Attainment of the NAAQS. It is also important to note that the degree of Nonattainment determines the thresholds of emissions that are considered to be "*de minimis,*" or levels below (i.e., within) which a formal General Conformity determination is not required.

Finally, the boundaries of Nonattainment areas are generally determined based on Core Based Statistical Areas (CBSA) as defined by U.S. census data (air monitoring station locations and contributing emission sources also play a role). However, Nonattainment areas for localized pollutants, such as lead and CO, typically only comprise a partial CBSA or a local "hot-spot." By comparison, regional pollutants such as O_3 can encompass multiple CBSAs and can extend across state lines.

State Implementation Plans (SIP)

For the purposes of this summary explanation of SIPs, it is sufficient to characterize SIPs as the principal instrument by which a state formulates and implements its strategies for bringing Nonattainment or Maintenance areas into compliance with the NAAQS. In equally broad terms, the SIP contains the necessary emission limitations, control measures and timetables for achieving this objective. Therefore, the SIP development process is delegated to state air quality agencies that may in turn rely on regional, county, and local agencies to help prepare emission inventories that include airport-related emissions.

Aircraft Fleet and Operational Data used in AEDT 2d

The Federal Aviation Administration (FAA) Aviation Environmental Design Tool (AEDT), Version 2d, which is the most current, was used in support of the 2017 air quality analysis.

Table I-4 contains the data that were used in AEDT 2d to represent actual conditions at Logan Airport in 2017. These data include aircraft type, engine, landing and takeoff cycles (LTOs), and taxi times. The aircraft are divided into four categories: air carrier (AC), cargo (CA), commuter (CO), and GA.

Table I-4 2017 Fleet Mix, Annual Landing and Takeoff Cycles (LTOs), and Taxi/Delay Time-in-Mode (TIM) by Aircraft Type

Aircraft Type	Engine	LTOs	Description (Airline)	Taxi Times
Air Carrier Aircraft				
Boeing 737-300 Series	CFM56-3-B1	10	AC (CHARTER)	26.57
Boeing 737-400 Series	CFM56-3B-2	29	AC (CHARTER)	26.57
Boeing 737-800 Series	CFM56-7B26	334	AC (CHARTER) AMX	26.57
Boeing 737-800 Series	CFM56-7B26	10	AC (CHARTER) BSK	26.57
Boeing 787-900 Dreamliner	Trent 1000-J2	324	AC (CHARTER) NAX	26.57
Boeing 737-800 Series	CFM56-7B26	53	AC (CHARTER) NAX	26.57
Boeing 737-400 Series	CFM56-3B-2	16	AC (CHARTER) SWQ	26.57
Airbus A330-200 Series	PW4168A	75	AC (CHARTER) TCX	26.57
Airbus A319-100 Series	CFM56-5B6/P	4,291	AC AAL	26.57

Table I-4 2017 Fleet Mix, Annual Landing and Takeoff Cycles (LTOs), and Taxi/Delay Time-in-Mode (TIM) by Aircraft Type (Continued)

Aircraft Type	Engine	LTOs	Description (Airline)	Taxi Times
Air Carrier Aircraft (Continued)				
Airbus A320-200 Series	V2527-A5	720	AC AAL	26.57
Airbus A321-100 Series	V2533-A5	5,477	AC AAL	26.57
Airbus A330-200 Series	PW4168	62	AC AAL	26.57
Airbus A330-300 Series	PW4168A	9	AC AAL	26.57
Boeing 737-800 Series	CFM56-7B26	9,288	AC AAL	26.57
Boeing 757-200 Series	RB211-535E4B	1,337	AC AAL	26.57
Boeing 767-300 Series	CF6-80C2B6	7	AC AAL	26.57
Boeing 777-200 Series	Trent 892	1	AC AAL	26.57
Embraer ERJ190	CF34-10E6	4,453	AC AAL	26.57
Boeing MD-83	JT8D-219	3	AC AAL	26.57
Airbus A319-100 Series	CFM56-5A5	114	AC ACA	26.57
Airbus A320-200 Series	CFM56-5-A1	24	AC ACA	26.57
Airbus A321-100 Series	CFM56-5B3	7	AC ACA	26.57
Embraer ERJ190	CF34-10E5A1	1,829	AC ACA	26.57
Airbus A330-200 Series	CF6-80E1A4	36	AC AEA	26.57
Airbus A330-200 Series	CF6-80E1A3	76	AC AFR	26.57
Airbus A340-300 Series	CFM56-5C2	8	AC AFR	26.57
Boeing 777-200 Series	GE90-90B	233	AC AFR	26.57
Boeing 777-300 ER	GE 90-115B	64	AC AFR	26.57
Boeing 787-900 Dreamliner	GEnx-1B74/75/P1	62	AC AFR	26.57
Boeing 737-800 Series	CFM56-7B24	645	AC ASA	26.57
Boeing 737-900 Series	CFM56-7B27	1,031	AC ASA	26.57
Airbus A319-100 Series	CFM56-5B7	113	AC AVA	26.57
Airbus A330-200 Series	CF6-80E1A4	271	AC AZA	26.57
Boeing 777-200 Series	GE90-94B	3	AC AZA	26.57
Airbus A380-800 Series/Trent 970	TRENT9XX	89	AC BAW	26.57
Boeing 747-400 Series	RB211-524H	440	AC BAW	26.57
Boeing 777-200 Series	GE90-90B	495	AC BAW	26.57

Table I-4	2017 Fleet Mix, Annual Landing and Takeoff Cycles (LTOs), and Taxi/Delay Time-in-Mode (TIM) by Aircraft Type (Continued)			
Aircraft Type	**Engine**	**LTOs**	**Description (Airline)**	**Taxi Times**
Air Carrier Aircraft (Continued)				
Boeing 777-300 ER	GE90-115B	146	AC BAW	26.57
Boeing 787-900 Dreamliner	Trent 1000-J2	92	AC BAW	26.57
Airbus A330-200 Series	JT9D-70	139	AC BER	26.57
B787-8R	GEnx-1B64	46	AC CHH	26.57
Boeing 787-900 Dreamliner	Trent 1000-J2	470	AC CHH	26.57
Boeing 737-700 Series	CFM56-7B24	59	AC CMP	26.57
Boeing 737-800 Series	CFM56-7B26	306	AC CMP	26.57
Boeing 777-300 ER	GE90-115B	326	AC CPA	26.57
Airbus A319-100 Series	CFM56-5A5	3,570	AC DAL	26.57
Airbus A320-200 Series	CFM56-5A3	2,137	AC DAL	26.57
Airbus A321-100 Series	V2533-A5	2,759	AC DAL	26.57
Airbus A330-200 Series	PW4168 Talon II	5	AC DAL	26.57
Airbus A330-300 Series	PW4168A Talon II	586	AC DAL	26.57
Boeing 717-200 Series	BR700-715A1-30	2,750	AC DAL	26.57
Boeing 737-800 Series	CFM56-7B26	2,517	AC DAL	26.57
Boeing 737-900 Series	CFM56-7B26	749	AC DAL	26.57
Boeing 757-200 Series	PW2037	882	AC DAL	26.57
Boeing 757-300 Series	PW2040	2	AC DAL	26.57
Boeing 767-300 Series	CF6-80A2	672	AC DAL	26.57
Boeing 767-400 ER	CF6-80C2B7F	10	AC DAL	26.57
Boeing MD-88	JT8D-219	570	AC DAL	26.57
Boeing MD-90	V2525-D5	751	AC DAL	26.57
Airbus A330-300 Series	PW4168A	172	AC DLH	26.57
Airbus A340-300 Series	CFM56-5C4/P	5	AC DLH	26.57
Airbus A340-600 Series	Trent 556-61	83	AC DLH	26.57
Airbus A350-900 series	Trent 772	248	AC DLH	26.57
Boeing 747-400 Series	CF6-80C2B1F	2	AC DLH	26.57
Boeing 747-800 Freighter	GEnx-2B67	343	AC DLH	26.57

Table I-4 2017 Fleet Mix, Annual Landing and Takeoff Cycles (LTOs), and Taxi/Delay Time-in-Mode (TIM) by Aircraft Type (Continued)

Aircraft Type	Engine	LTOs	Description (Airline)	Taxi Times
Air Carrier Aircraft (Continued)				
Airbus A330-200 Series	CF6-80E1A2	71	AC EIN	26.57
Airbus A330-300 Series	CF6-80E1A4	588	AC EIN	26.57
Boeing 757-200 Series	PW2040	345	AC EIN	26.57
Boeing 767-200 Series	CF6-80A	2	AC EIN	26.57
Boeing 767-300 Series	PW4060	149	AC ELY	26.57
Airbus A330-200 Series	CF6-80E1A4	7	AC IBE	26.57
Airbus A330-300 Series	CF6-80E1A4	218	AC IBE	26.57
Airbus A340-600 Series	Trent 556-61	7	AC IBE	26.57
Boeing 757-200 Series	RB211-535E4	386	AC ICE	26.57
Boeing 757-300 Series	RB211-535E4B	8	AC ICE	26.57
Boeing 767-300 Series	CF6-80C2B6	239	AC ICE	26.57
B787-8R	GEnx-1B64	3	AC JAL	26.57
Boeing 787-900 Dreamliner	Trent 1000-J2	362	AC JAL	26.57
Airbus A320-200 Series	V2527-A5	20,879	AC JBU	26.57
Airbus A321-100 Series	V2533-A5	2,821	AC JBU	26.57
Embraer ERJ190	CF34-10E6	26,742	AC JBU	26.57
Boeing 777-200 Series	GE90-94B	2	AC KLM	26.57
Airbus A319-100 Series	V2522-A5	2,242	AC NKS	26.57
Airbus A320-200 Series	V2527-A5	1,870	AC NKS	26.57
Airbus A321-200 Series	V2533-A5	314	AC NKS	26.57
Airbus A350-900 series	Trent XWB-75	303	AC QTR	26.57
B787-8R	CFM56-5C4	61	AC QTR	26.57
Airbus A310-200 Series	CF6-80C2A2	371	AC RZO	26.57
Airbus A330-200 Series	PW4168A	1	AC RZO	26.57
Airbus A340-300 Series	CFM56-5C4	48	AC RZO	26.57
Boeing 777-200 Series	GE90-92B	2	AC RZO	26.57
Airbus A330-300 Series	Trent 772	42	AC SAS	26.57
Airbus A340-300 Series	CFM56-5C4	16	AC SAS	26.57

Table I-4 2017 Fleet Mix, Annual Landing and Takeoff Cycles (LTOs), and Taxi/Delay Time-in-Mode (TIM) by Aircraft Type (Continued)

Aircraft Type	Engine	LTOs	Description (Airline)	Taxi Times
Air Carrier Aircraft (Continued)				
Boeing 737-700 Series	CFM56-7B22/2	211	AC SAS	26.57
Boeing 737-700 Series	CFM56-7B22	278	AC SCX	26.57
Boeing 737-800 Series	CFM56-7B27	417	AC SCX	26.57
Boeing 737-800 MAX	LEAP-1A35A/33/33B2/32/30	16	AC SWA	26.57
Boeing 737-300 Series	CFM56-3-B1	1,622	AC SWA	26.57
Boeing 737-700 Series	CFM56-7B24	7,457	AC SWA	26.57
Boeing 737-800 Series	CFM56-7B26	2,970	AC SWA	26.57
Airbus A330-300 Series	Trent 772	349	AC SWR	26.57
Airbus A340-300 Series	CFM56-5C4	113	AC SWR	26.57
Airbus A330-200 Series	PW4168A	307	AC TAP	26.57
Airbus A330-300 Series	Trent 772	14	AC TAP	26.57
Airbus A330-200 Series	CF6-80E1A3	1	AC THY	26.57
Airbus A330-300 Series	Trent 772	307	AC THY	26.57
Airbus A380-800 Series/Trent 970	GP7200	1	AC UAE	26.57
Boeing 777-200-LR	GE90-110B1	16	AC UAE	26.57
Boeing 777-300 ER	GE90-115B	500	AC UAE	26.57
Airbus A319-100 Series	V2522-A5	189	AC UAL	26.57
Airbus A320-200 Series	V2527-A5	1,458	AC UAL	26.57
Boeing 737-700 Series	CFM56-7B24	751	AC UAL	26.57
Boeing 737-800 Series	CFM56-7B26	1,874	AC UAL	26.57
Boeing 737-900 Series	CFM56-7B26	5,453	AC UAL	26.57
Boeing 757-200 Series	PW2037	1,131	AC UAL	26.57
Boeing 757-300 Series	RB211-535E4B	1,020	AC UAL	26.57
Boeing 767-300 Series	PW4060	2	AC UAL	26.57
Boeing 767-400	CF6-80C2B8FA	7	AC UAL	26.57
Boeing 777-200 Series	PW4077	424	AC UAL	26.57
Boeing 777-300 ER	PW4090	9	AC UAL	26.57
Airbus A330-300 Series	Trent 772	158	AC VIR	26.57

Table I-4 2017 Fleet Mix, Annual Landing and Takeoff Cycles (LTOs), and Taxi/Delay Time-in-Mode (TIM) by Aircraft Type (Continued)

Aircraft Type	Engine	LTOs	Description (Airline)	Taxi Times
Air Carrier Aircraft (Continued)				
Airbus A340-600 Series	Trent 556-61	8	AC VIR	26.57
Boeing 747-400 Series	CF6-80C2B1F	1	AC VIR	26.57
Boeing 787-900 Dreamliner	Trent 1000-A	215	AC VIR	26.57
Airbus A319-100 Series	CFM56-5B6/P	28	AC VRD	26.57
Airbus A320-200 Series	V2527-A5	1,830	AC VRD	26.57
Airbus A321-200 Series	CFM56-5-A1	19	AC VRD	26.57
Airbus A320-200 Series	V2527-A5	1	AC WOW	26.57
Airbus A321-100 Series	V2533-A5	354	AC WOW	26.57
Airbus A330-300 Series	Trent 772	7	AC WOW	26.57
Total Air Carrier Aircraft LTOs		**140,053**		
Cargo Aircraft				
Airbus A330-200 Series	CF6-80A	38	CA ABX	26.57
Airbus A330-300 Series	PW2037	163	CA ATN	26.57
Boeing 757-200 Series	CF6-80C2A5F	410	CA FDX	26.57
Boeing 767-200 Series	JT9D-7R4E, -7R4E1	112	CA FDX	26.57
Airbus A319-100 Series	RB211-535E4	5	CA FDX	26.57
Airbus A330-200 Series	CF6-80C2B6	968	CA FDX	26.57
Airbus A319-100 Series	CF6-6D	289	CA FDX	26.57
Airbus A320-200 Series	CF6-80C2D1F	93	CA FDX	26.57
Airbus A321-100 Series	CF6-80E1A3	2	CA GTI	26.57
Embraer ERJ190	JT9D-7R4D, -7R4D1	66	CA GTI	26.57
Airbus A330-200 Series	PW4158	603	CA UPS	26.57
Bombardier CRJ-200	PW2040	216	CA UPS	26.57
Boeing 737-800 Series	CF6-80C2B6F	208	CA UPS	26.57
Boeing 737-900 Series	PT6A-114	193	CA WIG	26.57
Total Cargo Aircraft LTOs		**3,366**		

Table I-4 2017 Fleet Mix, Annual Landing and Takeoff Cycles (LTOs), and Taxi/Delay Time-in-Mode (TIM) by Aircraft Type (Continued)

Aircraft Type	Engine	LTOs	Description (Airline)	Taxi Times
Commuter Aircraft				
Bombardier CRJ-700	CF34-8C1	117	CO ASH	26.57
Embraer ERJ175-LR	CF34-8E5	46	CO ASH	26.57
Bombardier CRJ-700	CF34-8C1	761	CO ASQ	26.57
Bombardier CRJ-900	CF34-8C5A2	5	CO ASQ	26.57
Embraer ERJ145	AE3007A1P	1,064	CO ASQ	26.57
Bombardier CRJ-200	CF34-3B	1,864	CO AWI	26.57
Bombardier CRJ-200	CF34-3B	333	CO EDV	26.57
Bombardier CRJ-900	CF34-8C5	3,656	CO EDV	26.57
Bombardier CRJ-700	CF34-8C5	566	CO GJS	26.57
Bombardier CRJ-900	CF34-8C5	1,002	CO GJS	26.57
Bombardier CRJ-200	CF34-3B	2,542	CO JZA	26.57
Bombardier CRJ-900	CF34-8C5	431	CO JZA	26.57
Bombardier de Havilland Dash 8 Q100	PW120A	29	CO JZA	26.57
Bombardier de Havilland Dash 8 Q400	PW150A	11	CO JZA	26.57
Cessna 402	TIO-540-J2B2	16,618	CO KAP	26.57
Embraer ERJ145	AE3007A1	1	CO LOF	26.57
Bombardier de Havilland Dash 8 Q100	PW120A	43	CO PDT	26.57
Embraer ERJ145	AE3007A1E	365	CO PDT	26.57
Saab 340-B-Plus	CT7-9B	1,719	CO PEN	26.57
Bombardier de Havilland Dash 8 Q400	PW150A	1,950	CO POE	26.57
Embraer ERJ170	CF34-8E5	2,353	CO RPA	26.57
Embraer ERJ175-LR	CF34-8E5	186	CO RPA	26.57
Embraer ERJ175	CF34-8E5	3,458	CO RPA	26.57
Embraer ERJ170	CF34-8E5	735	CO SKV	26.57
Bombardier CRJ-900	CF34-8C5	34	CO SKW	26.57
Embraer ERJ175-LR	CF34-8E5	9	CO SKW	26.57

Table I-4 2017 Fleet Mix, Annual Landing and Takeoff Cycles (LTOs), and Taxi/Delay Time-in-Mode (TIM) by Aircraft Type (Continued)

Aircraft Type	Engine	LTOs	Description (Airline)	Taxi Times
Commuter Aircraft (Continued)				
Embraer ERJ170	CF34-8E5	54	CO TCF	26.57
Embraer ERJ175	CF34-8E5A1	155	CO TCF	26.57
Bombardier de Havilland Dash 8 Q400	PW150A	1,569	CO WEN	26.57
Total Commuter Aircraft LTOs		**41,676**		
General Aviation Aircraft				
Saab 340-B	CT7-5	1,795	GA	26.57
Bombardier Challenger 600	CF34-3A	1,187	GA	26.57
Gulfstream G400	TAY Mk611-8	1,182	GA	26.57
Gulfstream G500	SPEY Mk511	946	GA	26.57
Dassault Falcon 2000	CF700-2D	871	GA	26.57
Raytheon Hawker 800	TFE731-3	835	GA	26.57
Cirrus SR22	TIO-540-J2B2	832	GA	26.57
Cessna 402	TIO-540-J2B2	799	GA	26.57
Cessna 560 Citation XLS	JT15D-5, -5A, -5B	768	GA	26.57
Bombardier Global Express	BR700-710A1-10	626	GA	26.57
Raytheon Beechjet 400	JT15D-5, -5A, -5B	46	GA CNS	26.57
Pilatus PC-12	PT6A-67B	759	GA CNS	26.57
Cessna 560 Citation Excel	JT15D-5, -5A, -5B	764	GA EJA	26.57
Cessna 680 Citation Sovereign	PW308C	458	GA EJA	26.57
Embraer 505	PW530	397	GA EJA	26.57
Bombardier Challenger 300	AS907-1-1A	340	GA EJA	26.57
Dassault Falcon 2000	PW308C	278	GA EJA	26.57
Gulfstream G400	TAY Mk611-8	91	GA EJM	26.57
Cessna 560 Citation Excel	JT15D-5, -5A, -5B	73	GA EJM	26.57
Bombardier Challenger 300	AE3007A1	57	GA EJM	26.57
Gulfstream G500	BR700-710A1-10	50	GA EJM	26.57
Bombardier Challenger 600	CF34-3A	47	GA EJM	26.57

Table I-4 2017 Fleet Mix, Annual Landing and Takeoff Cycles (LTOs), and Taxi/Delay Time-in-Mode (TIM) by Aircraft Type (Continued)

Aircraft Type	Engine	LTOs	Description (Airline)	Taxi Times
General Aviation Aircraft (Continued)				
Raytheon Super King Air 300	PT6A-60A	453	GA GAJ	26.57
Cessna 560 Citation XLS	JT15D-5, -5A, -5B	99	GA GAJ	26.57
Dassault Falcon 900	TFE731-3	2	GA GAJ	26.57
Gulfstream G400	TAY Mk611-8	2	GA GAJ	26.57
GULFSTREAM AEROSPACE Gulfstream G650	BR-700-725A1-12	1	GA GAJ	26.57
Cessna 525B CitationJet	JT15D-4series	19	GA GPD	26.57
Cessna 525 CitationJet	JT15D-1 series	2	GA GPD	26.57
Pilatus PC-12	PT6A-67B	520	GA GPD	26.57
Bombardier Challenger 300	AE3007A1	241	GA LXJ	26.57
Gulfstream G400	TAY Mk611-8	42	GA LXJ	26.57
Embraer Legacy	AE3007A1P	29	GA LXJ	26.57
Bombardier Learjet 75	TFE731-3	29	GA LXJ	26.57
Bombardier Challenger 600	CF34-3B	23	GA LXJ	26.57
Cirrus SR22	TIO-540-J2B2	45	GA NGF	26.57
Cessna 182	IO-360-B	44	GA NGF	26.57
Raytheon Beech Bonanza 36	TIO-540-J2B2	37	GA NGF	26.57
Piper PA-24 Comanche	TIO-540-J2B2	34	GA NGF	26.57
Raytheon Beech Bonanza 36	TIO-540-J2B2	31	GA NGF	26.57
Cessna 750 Citation X	AE3007C	6	GA OPT	26.57
Embraer ERJ135	AE3007A1/3	31	GA OPT	26.57
Embraer 505	PW500	141	GA OPT	26.57
Raytheon Beechjet 400	JT15D-5, -5A, -5B	249	GA TMC	26.57
Bombardier Challenger 600	CF34-3B	3	GA TMC	26.57
Raytheon Hawker 800	TFE731-3	99	GA TMC	26.57
Cessna 750 Citation X	AE3007C	106	GA XOJ	26.57
Bombardier Challenger 300	AE3007A1	102	GA XOJ	26.57
Total General Aviation Aircraft LTOs		**15,591**		
Total Fleet LTOs		**200,686**		

Source: KBE, HMMH, and Federal Aviation Administration ASPM, 2019.

Table I-5 contains the data that were used in AEDT 2d to represent future forecast conditions at Logan Airport in the Future Planning Horizon where passengers projected are projected to reach 50 million annual air passengers in the next 10 to 15 years (the Future Planning Horizon), forecast to be accommodated in approximately 486,000 annual aircraft operations. These data include aircraft type, engine, LTOs, and taxi times. The aircraft are divided into four categories: air carrier (AC), cargo (CA), commuter (CO), and GA.

Table I-5 Future Planning Horizon Fleet Mix, Annual Landing and Takeoff Cycles (LTOs), and Taxi/Delay Time-in-Mode (TIM) by Aircraft Type

Aircraft Type	Engine	LTOs	Description (Airline)	Taxi Times
Air Carrier Aircraft				
Airbus A319-100 Series	CFM56-5B6/P	15,238	AC	25.64
Airbus A320-200 Series	V2527-A5	31,430	AC	25.64
Airbus A320-NEO	CFM56-5B4/3	4,444	AC	25.64
Airbus A321-200 Series	V2533-A5	16,031	AC	25.64
Airbus A321-NEO	CFM56-5B2/3	8,733	AC	25.64
ATR 42-500	PW127F	635	AC	25.64
Boeing 717-200 Series	BR700-715A1-30	1,587	AC	25.64
Boeing 737-700 Series	CFM56-7B24	7,619	AC	25.64
Boeing 737-700 MAX	LEAP-1A35A/33/33B2/32/30	1,587	AC	25.64
Boeing 737-800 Series	CFM56-7B26	17,618	AC	25.64
Boeing 737-900 Series	CFM56-7B26	6,667	AC	25.64
Boeing 737-900 MAX	LEAP-1A35A/33/33B2/32/30	2,539	AC	25.64
Bombardier CS-100	PW1524G	11,746	AC	25.64
Bombardier CS-300	CFM56-5B7/3	19,684	AC	25.64
Piper PA-31 Navajo	TIO-540-J2B2	16,509	AC	25.64
Boeing 737-800 MAX	LEAP-1A35A/33/33B2/32/30	10,000	AC	25.64
Boeing 757-300 Series	RB211-535E4B	1,587	AC	25.64
Boeing 777-200 Series	GE90-90B	1,905	AC	25.64
Airbus A319-NEO	CFM56-5B7/3	159	AC	25.64
Airbus A330-200 Series	PW4168A	635	AC	25.64
Airbus A330-300 Series	Trent 772	2858	AC	25.64
Airbus A330-900-NEO	Trent 772	1587	AC	25.64

Table I-5	Future Planning Horizon Fleet Mix, Annual Landing and Takeoff Cycles (LTOs), and Taxi/Delay Time-in-Mode (TIM) by Aircraft Type (Continued)

Aircraft Type	Engine	LTOs	Description (Airline)	Taxi Times
Air Carrier Aircraft				
Airbus A350-900 series	Trent XWB-75	634	AC	25.64
7478	GEnx-2B67	317	AC	25.64
Boeing 777-300 Series	GE90-92B	952	AC	25.64
B787-8R	CFM56-5C4	1269	AC	25.64
Boeing 787-900 Dreamliner	Trent 1000-J2	1905	AC	25.64
Airbus A380-800 Series	TRENT970	317	AC	25.64
Boeing 777-9X	GE90-115	318	AC	25.64
Total Air Carrier Aircraft LTOs		**186,510**		
Cargo Aircraft				
Boeing 767-300 Series	CF6-80C2B6	3,356	CA	25.64
Boeing 757-200 Series	PW2040	650	CA	25.64
Total Cargo Aircraft LTOs		**4,006**		
Commuter Aircraft				
Bombardier CRJ-700	CF34-8C1	952	CO	25.64
Bombardier CRJ-900	CF34-8C5	9,206	CO	25.64
Bombardier de Havilland Dash 8 Q400	PW150A	3,810	CO	25.64
Embraer ERJ140	AE3007A3	2,222	CO	25.64
Embraer ERJ145	AE3007A1P	317	CO	25.64
Embraer ERJ175	CF34-8E5A1	14,603	CO	25.64
Saab 340-B	CT7-5	1,587	CO	25.64
Embraer ERJ170	CF34-8E5	4,127	CO	25.64
Total Commuter Aircraft LTOs		**36,824**		

Table I-5 Future Planning Horizon Fleet Mix, Annual Landing and Takeoff Cycles (LTOs), and Taxi/Delay Time-in-Mode (TIM) by Aircraft Type (Continued)

Aircraft Type	Engine	LTOs	Description (Airline)	Taxi Times
General Aviation Aircraft				
Raytheon Beech Baron 58	TIO-540-J2B2	3,250	GA	25.64
Bombardier Challenger 600	CF34-3A	7,583	GA	25.64
Cirrus SR22	TIO-540-J2B2	3,385	GA	25.64
Pilatus PC-12	PT6A-67B	541	GA	25.64
Cessna 560 Citation Excel	JT15D-5, -5A, -5B	812	GA	25.64
Embraer 505	PW530	271	GA	25.64
Total General Aviation Aircraft LTOs		**15,842**		
Total Fleet LTOs		**243,182**		

Note: AC - air carrier; CA – cargo; CO – commuter; GA – general aviation.

Ground Service Equipment (GSE) Time-in-Mode (TIM) Survey

A GSE time-in-mode (TIM) survey was conducted at Logan Airport on June 27-28, 2017. The purpose of the GSE TIM survey was to provide up-to-date GSE operating times, which directly affects GSE emissions. The last GSE TIM survey was conducted in 2012 in support of the *2011 Environmental Status and Planning Report (ESPR)*. The TIM is the average time that GSE and aircraft auxiliary power units (APUs) operate during a single aircraft LTO cycle. The surveyed TIM is used in place of the default TIM values in AEDT, thus yielding GSE emissions that best reflect the conditions at Logan Airport. The TIM survey focused on the most prevalent airlines (e.g., Southwest, JetBlue, American, Delta, and United) and the most common aircraft types, such as narrow body air carriers (e.g., A320, A321, B737, B757, etc.) and large commuter aircraft (e.g., ERJ170, ERJ190, CRJ700, CRJ900, etc.). The TIMs are provided in **Table I-6**.

Table I-6 Ground Service Equipment (GSE) Time-in-Mode (TIM) (minutes)

GSE Type	Narrow-Body Air Carriers	Large Commuter Aircraft
Aircraft Tractor	6.37	7.13
Baggage Tractor	27.23	17.43
Belt Loader	26.85	14.88
Cabin Service Truck	2.07	0.53
Catering Truck	11.30	13.28
Hydrant Truck	3.73	2.53
Lavatory Truck	4.82	2.45
Service Truck	0.12	0.57
Water Service Truck	1.65	0.75
Auxiliary Power Unit (APU)	16.63	14.70

Source: GSE TIM survey conducted by KBE with assistance from Massport (security escorts) on June 27-28, 2017.

Ground Service Equipment (GSE)/Alternative Fuels Conversion

For the 2017 analyses, GSE emissions were calculated using AEDT emission factors which are based on EPA NONROAD2008 model in combination with the recently updated GSE TIM survey and the GSE fuel types obtained from the Logan Airport Vehicle Aerodrome Permit Application. In this way, the most up-to-date GSE fleet operational, conversion, and emissions characteristics are used (**Table I-7**).

Table I-7 Ground Service Equipment (GSE) Alternative Fuel Conversion Summary (kg/day)

Year	Pollutant	Percent Reduction	Calculated Emissions without Reduction	Reduction from AFVs	Calculated Emissions with Reduction
2000	Volatile Organic Compounds (VOCs)	13.72%	178	24	154
	Oxides of Nitrogen (NO_x)	9.87%	369	36	333
	Carbon Monoxide (CO)	12.88%	6,124	789	5,335
2001	VOCs	13.72%	166	23	143
	NO_x	9.87%	338	33	305
	CO	12.88%	5,960	768	5,193
2002	VOCs	13.6%	286	39	247

Table I-7 Ground Service Equipment (GSE) Alternative Fuel Conversion Summary (kg/day) (Continued)

Year	Pollutant	Percent Reduction	Calculated Emissions without Reduction	Reduction from AFVs	Calculated Emissions with Reduction
	NO_x	8.0%	350	28	322
	CO	16.3%	6,174	1,004	5,170
2003	VOCs	13.8%	263	36	227
	NO_x	8.0%	316	25	291
	CO	16.4%	5,692	934	4,758
2004	VOCs	11.9%	212	25	187
	NO_x	6.6%	357	24	333
	CO	15.4%	4,236	650	3,586
2005	VOCs	12.2%	203	25	178
	NO_x	6.9%	335	23	312
	CO	15.4%	4,175	643	3,531
	$PM_{10}/PM_{2.5}$	9.9%	11	1	10
2006	VOCs	10.7%	86	9	77
	NO_x	7.5%	324	24	300
	CO	13.8%	1,841	255	1,586
	$PM_{10}/PM_{2.5}$	10.8%	10	1	9
2007	VOCs	8.2%	85	7	78
	NO_x	5.1%	315	16	299
	CO	10.4%	2,124	220	1,904
	$PM_{10}/PM_{2.5}$	5.9%	10	<1	10
2008	VOCs	8.3%	72	6	66
	NO_x	4.8%	270	13	257
	CO	10.2%	1,792	183	1,609
	$PM_{10}/PM_{2.5}$	5.6%	16	<1	15

Table I-7 Ground Service Equipment (GSE) Alternative Fuel Conversion Summary (kg/day) (Continued)

Year	Pollutant	Percent Reduction	Calculated Emissions without Reduction	Reduction from AFVs	Calculated Emissions with Reduction
2009	VOCs	8.2%	61	5	56
	NO_x	4.8%	230	11	219
	CO	10.0%	1,516	152	1,364
	$PM_{10}/PM_{2.5}$	3.5%	14	<1	14
2010	VOCs	7.5%	53	4	49
	NO_x	3.9%	206	8	198
	CO	8.5%	1,335	113	1,222
	$PM_{10}/PM_{2.5}$	2.5%	13	<1	13
2011	VOCs	13.2%	38	5	33
	NO_x	7.5%	188	14	173
	CO	16.7%	834	139	694
	$PM_{10}/PM_{2.5}$	5.5%	14	1	13
2012	VOCs	11.8%	34	4	30
	NO_x	6.8%	176	12	164
	CO	16.3%	738	120	618
	$PM_{10}/PM_{2.5}$	4.9%	13	<1	13
2013	VOCs	10.3%	29	3	26
	NO_x	6.5%	155	10	145
	CO	15.9%	634	101	533
	$PM_{10}/PM_{2.5}$	5.0%	12	<1	12
2014	VOCs	11.5%	26	3	23
	NO_x	5.6%	142	8	134
	CO	15.4%	572	88	484
	$PM_{10}/PM_{2.5}$	4.8%	12	<1	12

Table I-7 Ground Service Equipment (GSE) Alternative Fuel Conversion Summary (kg/day) (Continued)

Year	Pollutant	Percent Reduction	Calculated Emissions without Reduction	Reduction from AFVs	Calculated Emissions with Reduction
2015	VOCs	4.5%	22	1	21
	NO_x	5.2%	135	7	128
	CO	15.2%	521	79	442
	$PM_{10}/PM_{2.5}$	14.3%	14	2	12
2016	VOCs	9.0%	26	2	24
	NO_x	3.8%	173	6	167
	CO	13.5%	560	67	493
	$PM_{10}/PM_{2.5}$	2.6%	15	<1	15
2017	VOCs	8.7%	24	2	22
	NO_x	3.6%	148	5	143
	CO	13.7%	548	66	483
	$PM_{10}/PM_{2.5}$	3.8%	14	<1	14

Source: KBE and Massport.
Note: 2000 and 2001 analyses used EDMS v4.03. 2002 and 2003 analyses used EDMS v4.11, which used updated emission factors from the NONROAD2002 Model. 2004 analyses used EDMS v4.21, which again used emission factors from EPA NONROAD2002 Model. 2005 analysis used EDMS v4.5, which used emission factors from EPA NONROAD2002 Model. 2006 analysis used EDMS v5.0.1, which used emission factors from EPA NONROAD2005 Model. 2007 analysis used EDMS v5.0.2, which used emission factors from EPA NONROAD2005 Model. 2008 analysis used EDMS v5.1, which used emission factors from EPA NONROAD2005 Model. 2009 analysis used EDMS v5.1.2, which used emission factors from EPA NONROAD2005 Model. 2010, 2011, and 2012 analysis used EDMS v5.1.3, which used emission factors from EPA NONROAD2005 Model. 2013, 2014, 2015 analysis used EDMS v5.1.4.1, which used emission factors from EPA NONROAD2005. 2016 analysis used AEDT2c SP2, which used emission factors from EPA NONROAD2008 Model. 2017 analysis used AEDT 2d, which used emission factors from EPA NONROAD2008 Model.

Motor Vehicle Emissions

For the 2017 analysis, EPA's most current motor vehicle emission factor model MOVES2014b was used. The resultant emission factors were multiplied by average daily vehicle miles to calculate daily emissions. The on-Airport traffic data are summarized in the vehicle miles traveled (VMT) analyses of Appendix G, *Ground Access to and from Logan Airport.* Due to the new roadway configuration of the Ted Williams Tunnel, through-traffic no longer traverses Airport property. Therefore, as of 2003, emissions from these vehicles are no longer included as part of the Logan Airport emissions inventory. Further, MOVES2014b was used to obtain vehicle emissions at idle to estimate parking and curbside motor vehicle emissions.

Idling emissions are determined for a unit of time and multiplied by total idling time to reach the associated emissions. The input and output files of MOVES2014b for 2017 are included as **Tables I-8** and **I-9.** The input and output files of MOVES2014b for the Future Planning Horizon are included as **Tables I-10** and **I-11.**

Table I-8 MOVES2014b Sample Input File for 2017


```
<runspec version="MOVES2014b-20180726">
    <description><![CDATA[ESPR 2017 TB (CNG and diesel)
Winter January Hour 7
20 mph]]></description>
    <models>
        <model value="ONROAD"/>
    </models>
    <modelscale value="Inv"/>
    <modeldomain value="PROJECT"/>
    <geographicselections>
        <geographicselection type="COUNTY" key="25025" description="MASSACHUSETTS - Suffolk County"/>
    </geographicselections>
    <timespan>
        <year key="2017"/>
        <month id="1"/>
        <day id="5"/>
        <beginhour id="7"/>
        <endhour id="7"/>
        <aggregateBy key="Hour"/>
    </timespan>
    <onroadvehicleselections>
        <onroadvehicleselection fueltypeid="3" fueltypedesc="Compressed Natural Gas (CNG)" sourcetypeid="42"
sourcetypename="Transit Bus"/>
        <onroadvehicleselection fueltypeid="2" fueltypedesc="Diesel Fuel" sourcetypeid="42" sourcetypename="Transit Bus"/>
        <onroadvehicleselection fueltypeid="1" fueltypedesc="Gasoline" sourcetypeid="42" sourcetypename="Transit Bus"/>
    </onroadvehicleselections>
    <offroadvehicleselections>
    </offroadvehicleselections>
    <offroadvehiclesccs>
    </offroadvehiclesccs>
    <roadtypes separateramps="false">
        <roadtype roadtypeid="1" roadtypename="Off-Network" modelCombination="M1"/>
        <roadtype roadtypeid="5" roadtypename="Urban Unrestricted Access" modelCombination="M1"/>
    </roadtypes>
    <pollutantprocessassociations>
        <pollutantprocessassociation pollutantkey="58" pollutantname="Aluminum" processkey="1" processname="Running
Exhaust"/>
        <pollutantprocessassociation pollutantkey="58" pollutantname="Aluminum" processkey="2" processname="Start Exhaust"/>
        <pollutantprocessassociation pollutantkey="58" pollutantname="Aluminum" processkey="15" processname="Crankcase
Running Exhaust"/>
        <pollutantprocessassociation pollutantkey="58" pollutantname="Aluminum" processkey="16" processname="Crankcase Start
Exhaust"/>
```

<pollutantprocessassociation pollutantkey="58" pollutantname="Aluminum" processkey="17" processname="Crankcase Extended Idle Exhaust"/>
<pollutantprocessassociation pollutantkey="58" pollutantname="Aluminum" processkey="90" processname="Extended Idle Exhaust"/>
<pollutantprocessassociation pollutantkey="58" pollutantname="Aluminum" processkey="91" processname="Auxiliary Power Exhaust"/>
<pollutantprocessassociation pollutantkey="36" pollutantname="Ammonium (NH4)" processkey="1" processname="Running Exhaust"/>
<pollutantprocessassociation pollutantkey="36" pollutantname="Ammonium (NH4)" processkey="2" processname="Start Exhaust"/>
<pollutantprocessassociation pollutantkey="36" pollutantname="Ammonium (NH4)" processkey="15" processname="Crankcase Running Exhaust"/>
<pollutantprocessassociation pollutantkey="36" pollutantname="Ammonium (NH4)" processkey="16" processname="Crankcase Start Exhaust"/>
<pollutantprocessassociation pollutantkey="36" pollutantname="Ammonium (NH4)" processkey="17" processname="Crankcase Extended Idle Exhaust"/>
<pollutantprocessassociation pollutantkey="36" pollutantname="Ammonium (NH4)" processkey="90" processname="Extended Idle Exhaust"/>
<pollutantprocessassociation pollutantkey="36" pollutantname="Ammonium (NH4)" processkey="91" processname="Auxiliary Power Exhaust"/>
<pollutantprocessassociation pollutantkey="90" pollutantname="Atmospheric CO2" processkey="1" processname="Running Exhaust"/>
<pollutantprocessassociation pollutantkey="90" pollutantname="Atmospheric CO2" processkey="2" processname="Start Exhaust"/>
<pollutantprocessassociation pollutantkey="90" pollutantname="Atmospheric CO2" processkey="90" processname="Extended Idle Exhaust"/>
<pollutantprocessassociation pollutantkey="90" pollutantname="Atmospheric CO2" processkey="91" processname="Auxiliary Power Exhaust"/>
<pollutantprocessassociation pollutantkey="121" pollutantname="CMAQ5.0 Unspeciated (PMOTHR)" processkey="1" processname="Running Exhaust"/>
<pollutantprocessassociation pollutantkey="121" pollutantname="CMAQ5.0 Unspeciated (PMOTHR)" processkey="2" processname="Start Exhaust"/>
<pollutantprocessassociation pollutantkey="121" pollutantname="CMAQ5.0 Unspeciated (PMOTHR)" processkey="15" processname="Crankcase Running Exhaust"/>
<pollutantprocessassociation pollutantkey="121" pollutantname="CMAQ5.0 Unspeciated (PMOTHR)" processkey="16" processname="Crankcase Start Exhaust"/>
<pollutantprocessassociation pollutantkey="121" pollutantname="CMAQ5.0 Unspeciated (PMOTHR)" processkey="17" processname="Crankcase Extended Idle Exhaust"/>
<pollutantprocessassociation pollutantkey="121" pollutantname="CMAQ5.0 Unspeciated (PMOTHR)" processkey="90" processname="Extended Idle Exhaust"/>
<pollutantprocessassociation pollutantkey="121" pollutantname="CMAQ5.0 Unspeciated (PMOTHR)" processkey="91" processname="Auxiliary Power Exhaust"/>
<pollutantprocessassociation pollutantkey="98" pollutantname="CO2 Equivalent" processkey="1" processname="Running Exhaust"/>
<pollutantprocessassociation pollutantkey="98" pollutantname="CO2 Equivalent" processkey="2" processname="Start Exhaust"/>
<pollutantprocessassociation pollutantkey="98" pollutantname="CO2 Equivalent" processkey="90" processname="Extended Idle Exhaust"/>
<pollutantprocessassociation pollutantkey="98" pollutantname="CO2 Equivalent" processkey="91" processname="Auxiliary Power Exhaust"/>
<pollutantprocessassociation pollutantkey="55" pollutantname="Calcium" processkey="1" processname="Running Exhaust"/>

<pollutantprocessassociation pollutantkey="55" pollutantname="Calcium" processkey="2" processname="Start Exhaust"/>
<pollutantprocessassociation pollutantkey="55" pollutantname="Calcium" processkey="15" processname="Crankcase Running Exhaust"/>
<pollutantprocessassociation pollutantkey="55" pollutantname="Calcium" processkey="16" processname="Crankcase Start Exhaust"/>
<pollutantprocessassociation pollutantkey="55" pollutantname="Calcium" processkey="17" processname="Crankcase Extended Idle Exhaust"/>
<pollutantprocessassociation pollutantkey="55" pollutantname="Calcium" processkey="90" processname="Extended Idle Exhaust"/>
<pollutantprocessassociation pollutantkey="55" pollutantname="Calcium" processkey="91" processname="Auxiliary Power Exhaust"/>
<pollutantprocessassociation pollutantkey="2" pollutantname="Carbon Monoxide (CO)" processkey="1" processname="Running Exhaust"/>
<pollutantprocessassociation pollutantkey="2" pollutantname="Carbon Monoxide (CO)" processkey="2" processname="Start Exhaust"/>
<pollutantprocessassociation pollutantkey="2" pollutantname="Carbon Monoxide (CO)" processkey="15" processname="Crankcase Running Exhaust"/>
<pollutantprocessassociation pollutantkey="2" pollutantname="Carbon Monoxide (CO)" processkey="16" processname="Crankcase Start Exhaust"/>
<pollutantprocessassociation pollutantkey="2" pollutantname="Carbon Monoxide (CO)" processkey="17" processname="Crankcase Extended Idle Exhaust"/>
<pollutantprocessassociation pollutantkey="2" pollutantname="Carbon Monoxide (CO)" processkey="90" processname="Extended Idle Exhaust"/>
<pollutantprocessassociation pollutantkey="2" pollutantname="Carbon Monoxide (CO)" processkey="91" processname="Auxiliary Power Exhaust"/>
<pollutantprocessassociation pollutantkey="51" pollutantname="Chloride" processkey="1" processname="Running Exhaust"/>
<pollutantprocessassociation pollutantkey="51" pollutantname="Chloride" processkey="2" processname="Start Exhaust"/>
<pollutantprocessassociation pollutantkey="51" pollutantname="Chloride" processkey="15" processname="Crankcase Running Exhaust"/>
<pollutantprocessassociation pollutantkey="51" pollutantname="Chloride" processkey="16" processname="Crankcase Start Exhaust"/>
<pollutantprocessassociation pollutantkey="51" pollutantname="Chloride" processkey="17" processname="Crankcase Extended Idle Exhaust"/>
<pollutantprocessassociation pollutantkey="51" pollutantname="Chloride" processkey="90" processname="Extended Idle Exhaust"/>
<pollutantprocessassociation pollutantkey="51" pollutantname="Chloride" processkey="91" processname="Auxiliary Power Exhaust"/>
<pollutantprocessassociation pollutantkey="118" pollutantname="Composite - NonECPM" processkey="1" processname="Running Exhaust"/>
<pollutantprocessassociation pollutantkey="118" pollutantname="Composite - NonECPM" processkey="2" processname="Start Exhaust"/>
<pollutantprocessassociation pollutantkey="118" pollutantname="Composite - NonECPM" processkey="15" processname="Crankcase Running Exhaust"/>
<pollutantprocessassociation pollutantkey="118" pollutantname="Composite - NonECPM" processkey="16" processname="Crankcase Start Exhaust"/>
<pollutantprocessassociation pollutantkey="118" pollutantname="Composite - NonECPM" processkey="17" processname="Crankcase Extended Idle Exhaust"/>
<pollutantprocessassociation pollutantkey="118" pollutantname="Composite - NonECPM" processkey="90" processname="Extended Idle Exhaust"/>

<pollutantprocessassociation pollutantkey="118" pollutantname="Composite - NonECPM" processkey="91" processname="Auxiliary Power Exhaust"/>

<pollutantprocessassociation pollutantkey="112" pollutantname="Elemental Carbon" processkey="1" processname="Running Exhaust"/>

<pollutantprocessassociation pollutantkey="112" pollutantname="Elemental Carbon" processkey="2" processname="Start Exhaust"/>

<pollutantprocessassociation pollutantkey="112" pollutantname="Elemental Carbon" processkey="15" processname="Crankcase Running Exhaust"/>

<pollutantprocessassociation pollutantkey="112" pollutantname="Elemental Carbon" processkey="16" processname="Crankcase Start Exhaust"/>

<pollutantprocessassociation pollutantkey="112" pollutantname="Elemental Carbon" processkey="17" processname="Crankcase Extended Idle Exhaust"/>

<pollutantprocessassociation pollutantkey="112" pollutantname="Elemental Carbon" processkey="90" processname="Extended Idle Exhaust"/>

<pollutantprocessassociation pollutantkey="112" pollutantname="Elemental Carbon" processkey="91" processname="Auxiliary Power Exhaust"/>

<pollutantprocessassociation pollutantkey="119" pollutantname="H2O (aerosol)" processkey="1" processname="Running Exhaust"/>

<pollutantprocessassociation pollutantkey="119" pollutantname="H2O (aerosol)" processkey="2" processname="Start Exhaust"/>

<pollutantprocessassociation pollutantkey="119" pollutantname="H2O (aerosol)" processkey="15" processname="Crankcase Running Exhaust"/>

<pollutantprocessassociation pollutantkey="119" pollutantname="H2O (aerosol)" processkey="16" processname="Crankcase Start Exhaust"/>

<pollutantprocessassociation pollutantkey="119" pollutantname="H2O (aerosol)" processkey="17" processname="Crankcase Extended Idle Exhaust"/>

<pollutantprocessassociation pollutantkey="119" pollutantname="H2O (aerosol)" processkey="90" processname="Extended Idle Exhaust"/>

<pollutantprocessassociation pollutantkey="119" pollutantname="H2O (aerosol)" processkey="91" processname="Auxiliary Power Exhaust"/>

<pollutantprocessassociation pollutantkey="59" pollutantname="Iron" processkey="1" processname="Running Exhaust"/>

<pollutantprocessassociation pollutantkey="59" pollutantname="Iron" processkey="2" processname="Start Exhaust"/>

<pollutantprocessassociation pollutantkey="59" pollutantname="Iron" processkey="15" processname="Crankcase Running Exhaust"/>

<pollutantprocessassociation pollutantkey="59" pollutantname="Iron" processkey="16" processname="Crankcase Start Exhaust"/>

<pollutantprocessassociation pollutantkey="59" pollutantname="Iron" processkey="17" processname="Crankcase Extended Idle Exhaust"/>

<pollutantprocessassociation pollutantkey="59" pollutantname="Iron" processkey="90" processname="Extended Idle Exhaust"/>

<pollutantprocessassociation pollutantkey="59" pollutantname="Iron" processkey="91" processname="Auxiliary Power Exhaust"/>

<pollutantprocessassociation pollutantkey="54" pollutantname="Magnesium" processkey="1" processname="Running Exhaust"/>

<pollutantprocessassociation pollutantkey="54" pollutantname="Magnesium" processkey="2" processname="Start Exhaust"/>

<pollutantprocessassociation pollutantkey="54" pollutantname="Magnesium" processkey="15" processname="Crankcase Running Exhaust"/>

<pollutantprocessassociation pollutantkey="54" pollutantname="Magnesium" processkey="16" processname="Crankcase Start Exhaust"/>

<pollutantprocessassociation pollutantkey="54" pollutantname="Magnesium" processkey="17" processname="Crankcase Extended Idle Exhaust"/>
<pollutantprocessassociation pollutantkey="54" pollutantname="Magnesium" processkey="90" processname="Extended Idle Exhaust"/>
<pollutantprocessassociation pollutantkey="54" pollutantname="Magnesium" processkey="91" processname="Auxiliary Power Exhaust"/>
<pollutantprocessassociation pollutantkey="66" pollutantname="Manganese Compounds" processkey="1" processname="Running Exhaust"/>
<pollutantprocessassociation pollutantkey="5" pollutantname="Methane (CH4)" processkey="1" processname="Running Exhaust"/>
<pollutantprocessassociation pollutantkey="5" pollutantname="Methane (CH4)" processkey="2" processname="Start Exhaust"/>
<pollutantprocessassociation pollutantkey="5" pollutantname="Methane (CH4)" processkey="15" processname="Crankcase Running Exhaust"/>
<pollutantprocessassociation pollutantkey="5" pollutantname="Methane (CH4)" processkey="16" processname="Crankcase Start Exhaust"/>
<pollutantprocessassociation pollutantkey="5" pollutantname="Methane (CH4)" processkey="17" processname="Crankcase Extended Idle Exhaust"/>
<pollutantprocessassociation pollutantkey="5" pollutantname="Methane (CH4)" processkey="90" processname="Extended Idle Exhaust"/>
<pollutantprocessassociation pollutantkey="5" pollutantname="Methane (CH4)" processkey="91" processname="Auxiliary Power Exhaust"/>
<pollutantprocessassociation pollutantkey="35" pollutantname="Nitrate (NO3)" processkey="1" processname="Running Exhaust"/>
<pollutantprocessassociation pollutantkey="35" pollutantname="Nitrate (NO3)" processkey="2" processname="Start Exhaust"/>
<pollutantprocessassociation pollutantkey="35" pollutantname="Nitrate (NO3)" processkey="15" processname="Crankcase Running Exhaust"/>
<pollutantprocessassociation pollutantkey="35" pollutantname="Nitrate (NO3)" processkey="16" processname="Crankcase Start Exhaust"/>
<pollutantprocessassociation pollutantkey="35" pollutantname="Nitrate (NO3)" processkey="17" processname="Crankcase Extended Idle Exhaust"/>
<pollutantprocessassociation pollutantkey="35" pollutantname="Nitrate (NO3)" processkey="90" processname="Extended Idle Exhaust"/>
<pollutantprocessassociation pollutantkey="35" pollutantname="Nitrate (NO3)" processkey="91" processname="Auxiliary Power Exhaust"/>
<pollutantprocessassociation pollutantkey="6" pollutantname="Nitrous Oxide (N2O)" processkey="1" processname="Running Exhaust"/>
<pollutantprocessassociation pollutantkey="6" pollutantname="Nitrous Oxide (N2O)" processkey="2" processname="Start Exhaust"/>
<pollutantprocessassociation pollutantkey="6" pollutantname="Nitrous Oxide (N2O)" processkey="15" processname="Crankcase Running Exhaust"/>
<pollutantprocessassociation pollutantkey="6" pollutantname="Nitrous Oxide (N2O)" processkey="16" processname="Crankcase Start Exhaust"/>
<pollutantprocessassociation pollutantkey="79" pollutantname="Non-Methane Hydrocarbons" processkey="1" processname="Running Exhaust"/>
<pollutantprocessassociation pollutantkey="79" pollutantname="Non-Methane Hydrocarbons" processkey="2" processname="Start Exhaust"/>
<pollutantprocessassociation pollutantkey="79" pollutantname="Non-Methane Hydrocarbons" processkey="11" processname="Evap Permeation"/>

<pollutantprocessassociation pollutantkey="79" pollutantname="Non-Methane Hydrocarbons" processkey="13" processname="Evap Fuel Leaks"/>
<pollutantprocessassociation pollutantkey="79" pollutantname="Non-Methane Hydrocarbons" processkey="90" processname="Extended Idle Exhaust"/>
<pollutantprocessassociation pollutantkey="79" pollutantname="Non-Methane Hydrocarbons" processkey="91" processname="Auxiliary Power Exhaust"/>
<pollutantprocessassociation pollutantkey="122" pollutantname="Non-carbon Organic Matter (NCOM)" processkey="1" processname="Running Exhaust"/>
<pollutantprocessassociation pollutantkey="122" pollutantname="Non-carbon Organic Matter (NCOM)" processkey="2" processname="Start Exhaust"/>
<pollutantprocessassociation pollutantkey="122" pollutantname="Non-carbon Organic Matter (NCOM)" processkey="15" processname="Crankcase Running Exhaust"/>
<pollutantprocessassociation pollutantkey="122" pollutantname="Non-carbon Organic Matter (NCOM)" processkey="16" processname="Crankcase Start Exhaust"/>
<pollutantprocessassociation pollutantkey="122" pollutantname="Non-carbon Organic Matter (NCOM)" processkey="17" processname="Crankcase Extended Idle Exhaust"/>
<pollutantprocessassociation pollutantkey="122" pollutantname="Non-carbon Organic Matter (NCOM)" processkey="90" processname="Extended Idle Exhaust"/>
<pollutantprocessassociation pollutantkey="122" pollutantname="Non-carbon Organic Matter (NCOM)" processkey="91" processname="Auxiliary Power Exhaust"/>
<pollutantprocessassociation pollutantkey="111" pollutantname="Organic Carbon" processkey="1" processname="Running Exhaust"/>
<pollutantprocessassociation pollutantkey="111" pollutantname="Organic Carbon" processkey="2" processname="Start Exhaust"/>
<pollutantprocessassociation pollutantkey="111" pollutantname="Organic Carbon" processkey="15" processname="Crankcase Running Exhaust"/>
<pollutantprocessassociation pollutantkey="111" pollutantname="Organic Carbon" processkey="16" processname="Crankcase Start Exhaust"/>
<pollutantprocessassociation pollutantkey="111" pollutantname="Organic Carbon" processkey="17" processname="Crankcase Extended Idle Exhaust"/>
<pollutantprocessassociation pollutantkey="111" pollutantname="Organic Carbon" processkey="90" processname="Extended Idle Exhaust"/>
<pollutantprocessassociation pollutantkey="111" pollutantname="Organic Carbon" processkey="91" processname="Auxiliary Power Exhaust"/>
<pollutantprocessassociation pollutantkey="3" pollutantname="Oxides of Nitrogen (NOx)" processkey="1" processname="Running Exhaust"/>
<pollutantprocessassociation pollutantkey="3" pollutantname="Oxides of Nitrogen (NOx)" processkey="2" processname="Start Exhaust"/>
<pollutantprocessassociation pollutantkey="3" pollutantname="Oxides of Nitrogen (NOx)" processkey="15" processname="Crankcase Running Exhaust"/>
<pollutantprocessassociation pollutantkey="3" pollutantname="Oxides of Nitrogen (NOx)" processkey="16" processname="Crankcase Start Exhaust"/>
<pollutantprocessassociation pollutantkey="3" pollutantname="Oxides of Nitrogen (NOx)" processkey="17" processname="Crankcase Extended Idle Exhaust"/>
<pollutantprocessassociation pollutantkey="3" pollutantname="Oxides of Nitrogen (NOx)" processkey="90" processname="Extended Idle Exhaust"/>
<pollutantprocessassociation pollutantkey="3" pollutantname="Oxides of Nitrogen (NOx)" processkey="91" processname="Auxiliary Power Exhaust"/>
<pollutantprocessassociation pollutantkey="53" pollutantname="Potassium" processkey="1" processname="Running Exhaust"/>
<pollutantprocessassociation pollutantkey="53" pollutantname="Potassium" processkey="2" processname="Start Exhaust"/>

<pollutantprocessassociation pollutantkey="53" pollutantname="Potassium" processkey="15" processname="Crankcase Running Exhaust"/>
<pollutantprocessassociation pollutantkey="53" pollutantname="Potassium" processkey="16" processname="Crankcase Start Exhaust"/>
<pollutantprocessassociation pollutantkey="53" pollutantname="Potassium" processkey="17" processname="Crankcase Extended Idle Exhaust"/>
<pollutantprocessassociation pollutantkey="53" pollutantname="Potassium" processkey="90" processname="Extended Idle Exhaust"/>
<pollutantprocessassociation pollutantkey="53" pollutantname="Potassium" processkey="91" processname="Auxiliary Power Exhaust"/>
<pollutantprocessassociation pollutantkey="100" pollutantname="Primary Exhaust PM10 - Total" processkey="1" processname="Running Exhaust"/>
<pollutantprocessassociation pollutantkey="100" pollutantname="Primary Exhaust PM10 - Total" processkey="2" processname="Start Exhaust"/>
<pollutantprocessassociation pollutantkey="100" pollutantname="Primary Exhaust PM10 - Total" processkey="15" processname="Crankcase Running Exhaust"/>
<pollutantprocessassociation pollutantkey="100" pollutantname="Primary Exhaust PM10 - Total" processkey="16" processname="Crankcase Start Exhaust"/>
<pollutantprocessassociation pollutantkey="100" pollutantname="Primary Exhaust PM10 - Total" processkey="17" processname="Crankcase Extended Idle Exhaust"/>
<pollutantprocessassociation pollutantkey="100" pollutantname="Primary Exhaust PM10 - Total" processkey="90" processname="Extended Idle Exhaust"/>
<pollutantprocessassociation pollutantkey="100" pollutantname="Primary Exhaust PM10 - Total" processkey="91" processname="Auxiliary Power Exhaust"/>
<pollutantprocessassociation pollutantkey="110" pollutantname="Primary Exhaust PM2.5 - Total" processkey="1" processname="Running Exhaust"/>
<pollutantprocessassociation pollutantkey="110" pollutantname="Primary Exhaust PM2.5 - Total" processkey="2" processname="Start Exhaust"/>
<pollutantprocessassociation pollutantkey="110" pollutantname="Primary Exhaust PM2.5 - Total" processkey="15" processname="Crankcase Running Exhaust"/>
<pollutantprocessassociation pollutantkey="110" pollutantname="Primary Exhaust PM2.5 - Total" processkey="16" processname="Crankcase Start Exhaust"/>
<pollutantprocessassociation pollutantkey="110" pollutantname="Primary Exhaust PM2.5 - Total" processkey="17" processname="Crankcase Extended Idle Exhaust"/>
<pollutantprocessassociation pollutantkey="110" pollutantname="Primary Exhaust PM2.5 - Total" processkey="90" processname="Extended Idle Exhaust"/>
<pollutantprocessassociation pollutantkey="110" pollutantname="Primary Exhaust PM2.5 - Total" processkey="91" processname="Auxiliary Power Exhaust"/>
<pollutantprocessassociation pollutantkey="106" pollutantname="Primary PM10 - Brakewear Particulate" processkey="9" processname="Brakewear"/>
<pollutantprocessassociation pollutantkey="107" pollutantname="Primary PM10 - Tirewear Particulate" processkey="10" processname="Tirewear"/>
<pollutantprocessassociation pollutantkey="116" pollutantname="Primary PM2.5 - Brakewear Particulate" processkey="9" processname="Brakewear"/>
<pollutantprocessassociation pollutantkey="117" pollutantname="Primary PM2.5 - Tirewear Particulate" processkey="10" processname="Tirewear"/>
<pollutantprocessassociation pollutantkey="57" pollutantname="Silicon" processkey="1" processname="Running Exhaust"/>
<pollutantprocessassociation pollutantkey="57" pollutantname="Silicon" processkey="2" processname="Start Exhaust"/>
<pollutantprocessassociation pollutantkey="57" pollutantname="Silicon" processkey="15" processname="Crankcase Running Exhaust"/>

<pollutantprocessassociation pollutantkey="57" pollutantname="Silicon" processkey="16" processname="Crankcase Start Exhaust"/>
<pollutantprocessassociation pollutantkey="57" pollutantname="Silicon" processkey="17" processname="Crankcase Extended Idle Exhaust"/>
<pollutantprocessassociation pollutantkey="57" pollutantname="Silicon" processkey="90" processname="Extended Idle Exhaust"/>
<pollutantprocessassociation pollutantkey="57" pollutantname="Silicon" processkey="91" processname="Auxiliary Power Exhaust"/>
<pollutantprocessassociation pollutantkey="52" pollutantname="Sodium" processkey="1" processname="Running Exhaust"/>
<pollutantprocessassociation pollutantkey="52" pollutantname="Sodium" processkey="2" processname="Start Exhaust"/>
<pollutantprocessassociation pollutantkey="52" pollutantname="Sodium" processkey="15" processname="Crankcase Running Exhaust"/>
<pollutantprocessassociation pollutantkey="52" pollutantname="Sodium" processkey="16" processname="Crankcase Start Exhaust"/>
<pollutantprocessassociation pollutantkey="52" pollutantname="Sodium" processkey="17" processname="Crankcase Extended Idle Exhaust"/>
<pollutantprocessassociation pollutantkey="52" pollutantname="Sodium" processkey="90" processname="Extended Idle Exhaust"/>
<pollutantprocessassociation pollutantkey="52" pollutantname="Sodium" processkey="91" processname="Auxiliary Power Exhaust"/>
<pollutantprocessassociation pollutantkey="115" pollutantname="Sulfate Particulate" processkey="1" processname="Running Exhaust"/>
<pollutantprocessassociation pollutantkey="115" pollutantname="Sulfate Particulate" processkey="2" processname="Start Exhaust"/>
<pollutantprocessassociation pollutantkey="115" pollutantname="Sulfate Particulate" processkey="15" processname="Crankcase Running Exhaust"/>
<pollutantprocessassociation pollutantkey="115" pollutantname="Sulfate Particulate" processkey="16" processname="Crankcase Start Exhaust"/>
<pollutantprocessassociation pollutantkey="115" pollutantname="Sulfate Particulate" processkey="17" processname="Crankcase Extended Idle Exhaust"/>
<pollutantprocessassociation pollutantkey="115" pollutantname="Sulfate Particulate" processkey="90" processname="Extended Idle Exhaust"/>
<pollutantprocessassociation pollutantkey="115" pollutantname="Sulfate Particulate" processkey="91" processname="Auxiliary Power Exhaust"/>
<pollutantprocessassociation pollutantkey="31" pollutantname="Sulfur Dioxide (SO2)" processkey="1" processname="Running Exhaust"/>
<pollutantprocessassociation pollutantkey="31" pollutantname="Sulfur Dioxide (SO2)" processkey="2" processname="Start Exhaust"/>
<pollutantprocessassociation pollutantkey="31" pollutantname="Sulfur Dioxide (SO2)" processkey="15" processname="Crankcase Running Exhaust"/>
<pollutantprocessassociation pollutantkey="31" pollutantname="Sulfur Dioxide (SO2)" processkey="16" processname="Crankcase Start Exhaust"/>
<pollutantprocessassociation pollutantkey="31" pollutantname="Sulfur Dioxide (SO2)" processkey="17" processname="Crankcase Extended Idle Exhaust"/>
<pollutantprocessassociation pollutantkey="31" pollutantname="Sulfur Dioxide (SO2)" processkey="90" processname="Extended Idle Exhaust"/>
<pollutantprocessassociation pollutantkey="31" pollutantname="Sulfur Dioxide (SO2)" processkey="91" processname="Auxiliary Power Exhaust"/>
<pollutantprocessassociation pollutantkey="56" pollutantname="Titanium" processkey="1" processname="Running Exhaust"/>
<pollutantprocessassociation pollutantkey="56" pollutantname="Titanium" processkey="2" processname="Start Exhaust"/>

<pollutantprocessassociation pollutantkey="56" pollutantname="Titanium" processkey="15" processname="Crankcase Running Exhaust"/>
<pollutantprocessassociation pollutantkey="56" pollutantname="Titanium" processkey="16" processname="Crankcase Start Exhaust"/>
<pollutantprocessassociation pollutantkey="56" pollutantname="Titanium" processkey="17" processname="Crankcase Extended Idle Exhaust"/>
<pollutantprocessassociation pollutantkey="56" pollutantname="Titanium" processkey="90" processname="Extended Idle Exhaust"/>
<pollutantprocessassociation pollutantkey="56" pollutantname="Titanium" processkey="91" processname="Auxiliary Power Exhaust"/>
<pollutantprocessassociation pollutantkey="91" pollutantname="Total Energy Consumption" processkey="1" processname="Running Exhaust"/>
<pollutantprocessassociation pollutantkey="91" pollutantname="Total Energy Consumption" processkey="2" processname="Start Exhaust"/>
<pollutantprocessassociation pollutantkey="91" pollutantname="Total Energy Consumption" processkey="90" processname="Extended Idle Exhaust"/>
<pollutantprocessassociation pollutantkey="91" pollutantname="Total Energy Consumption" processkey="91" processname="Auxiliary Power Exhaust"/>
<pollutantprocessassociation pollutantkey="1" pollutantname="Total Gaseous Hydrocarbons" processkey="1" processname="Running Exhaust"/>
<pollutantprocessassociation pollutantkey="1" pollutantname="Total Gaseous Hydrocarbons" processkey="2" processname="Start Exhaust"/>
<pollutantprocessassociation pollutantkey="1" pollutantname="Total Gaseous Hydrocarbons" processkey="11" processname="Evap Permeation"/>
<pollutantprocessassociation pollutantkey="1" pollutantname="Total Gaseous Hydrocarbons" processkey="13" processname="Evap Fuel Leaks"/>
<pollutantprocessassociation pollutantkey="1" pollutantname="Total Gaseous Hydrocarbons" processkey="90" processname="Extended Idle Exhaust"/>
<pollutantprocessassociation pollutantkey="1" pollutantname="Total Gaseous Hydrocarbons" processkey="91" processname="Auxiliary Power Exhaust"/>
<pollutantprocessassociation pollutantkey="87" pollutantname="Volatile Organic Compounds" processkey="1" processname="Running Exhaust"/>
<pollutantprocessassociation pollutantkey="87" pollutantname="Volatile Organic Compounds" processkey="2" processname="Start Exhaust"/>
<pollutantprocessassociation pollutantkey="87" pollutantname="Volatile Organic Compounds" processkey="11" processname="Evap Permeation"/>
<pollutantprocessassociation pollutantkey="87" pollutantname="Volatile Organic Compounds" processkey="13" processname="Evap Fuel Leaks"/>
<pollutantprocessassociation pollutantkey="87" pollutantname="Volatile Organic Compounds" processkey="15" processname="Crankcase Running Exhaust"/>
<pollutantprocessassociation pollutantkey="87" pollutantname="Volatile Organic Compounds" processkey="16" processname="Crankcase Start Exhaust"/>
<pollutantprocessassociation pollutantkey="87" pollutantname="Volatile Organic Compounds" processkey="17" processname="Crankcase Extended Idle Exhaust"/>
<pollutantprocessassociation pollutantkey="87" pollutantname="Volatile Organic Compounds" processkey="90" processname="Extended Idle Exhaust"/>
<pollutantprocessassociation pollutantkey="87" pollutantname="Volatile Organic Compounds" processkey="91" processname="Auxiliary Power Exhaust"/>
</pollutantprocessassociations>
<databaseselections>

```
<databaseselection servername="" databasename="mylevs" description=""/>
</databaseselections>
<internalcontrolstrategies>
<internalcontrolstrategy
classname="gov.epa.otaq.moves.master.implementation.ghg.internalcontrolstrategies.rateofprogress.RateOfProgressStrategy"><![CDAT
A[
useParameters   No

]]></internalcontrolstrategy>
</internalcontrolstrategies>
<inputdatabase servername="" databasename="" description=""/>
<uncertaintyparameters uncertaintymodeenabled="false" numberofrunspersimulation="0" numberofsimulations="0"/>
<geographicoutputdetail description="LINK"/>
<outputemissionsbreakdownselection>
<modelyear selected="true"/>
<fueltype selected="true"/>
<fuelsubtype selected="false"/>
<emissionprocess selected="false"/>
<onroadoffroad selected="true"/>
<roadtype selected="false"/>
<sourceusetype selected="false"/>
<movesvehicletype selected="false"/>
<onroadscc selected="false"/>
<estimateuncertainty selected="false" numberOfIterations="2" keepSampledData="false" keepIterations="false"/>
<sector selected="false"/>
<engtechid selected="false"/>
<hpclass selected="false"/>
<regclassid selected="false"/>
</outputemissionsbreakdownselection>
<outputdatabase servername="" databasename="espr2017w_tb_out_2" description=""/>
<outputtimestep value="Hour"/>
<outputvmtdata value="true"/>
<outputsho value="true"/>
<outputsh value="true"/>
<outputshp value="true"/>
<outputshidling value="true"/>
<outputstarts value="true"/>
<outputpopulation value="true"/>
<scaleinputdatabase servername="localhost" databasename="espr2017w_tb_actual_in" description=""/>
<pmsize value="0"/>
<outputfactors>
<timefactors selected="true" units="Hours"/>
<distancefactors selected="true" units="Miles"/>
<massfactors selected="true" units="Grams" energyunits="Million BTU"/>
</outputfactors>
```

<savedata>

</savedata>

<donotexecute>

</donotexecute>

<generatordatabase shouldsave="false" servername="" databasename="" description=""/>
<donotperformfinalaggregation selected="false"/>
<lookuptableflags scenarioid="" truncateoutput="true" truncateactivity="true" truncatebaserates="true"/>
</runspec>

Source: KBE and Massport, 2019.

Table I-9 MOVES2014b Sample Output File for 2017

MasterKey	MOVESRunID	iterationID	yearID	monthID	dayID	hourID	stateID	countyID	zoneID	linkID	pollutantID	processID	sourceTypeID	regClassId	fuelTypeID	modelYearID	roadTypeID	SCC	emissionQuant	activityTypeID	activity	emissionRate	massUnits	distanceUnits
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2017,0,00	1	1	2017	1	5	7	25	25025	250250	1	122	NULL	0	0	2	2017	0	0	2.43768E-05	1	0.046585601	0.000523269	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2017,0,00	1	1	2017	1	5	7	25	25025	250250	1	121	NULL	0	0	2	2017	0	0	4.25954E-06	1	0.046585601	9.14347E-05	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2017,0,00	1	1	2017	1	5	7	25	25025	250250	1	119	NULL	0	0	2	2017	0	0	0	1	0.046585601	0	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2017,0,00	1	1	2017	1	5	7	25	25025	250250	1	118	NULL	0	0	2	2017	0	0	0.000713675	1	0.046585601	0.015319648	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2017,0,00	1	1	2017	1	5	7	25	25025	250250	1	117	NULL	0	0	2	2017	0	0	0.000179121	1	0.046585601	0.003844986	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2017,0,00	1	1	2017	1	5	7	25	25025	250250	1	116	NULL	0	0	2	2017	0	0	0.00144878	1	0.046585601	0.031099308	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2017,0,00	1	1	2017	1	5	7	25	25025	250250	1	115	NULL	0	0	2	2017	0	0	0.000549345	1	0.046585601	0.011792163	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2017,0,00	1	1	2017	1	5	7	25	25025	250250	1	112	NULL	0	0	2	2017	0	0	7.01035E-05	1	0.046585601	0.001504832	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2017,0,00	1	1	2017	1	5	7	25	25025	250250	1	111	NULL	0	0	2	2017	0	0	0.000121884	1	0.046585601	0.002616345	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2017,0,00	1	1	2017	1	5	7	25	25025	250250	1	110	NULL	0	0	2	2017	0	0	0.000783778	1	0.046585601	0.01682447	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2017,0,00	1	1	2017	1	5	7	25	25025	250250	1	107	NULL	0	0	2	2017	0	0	0.00119415	1	0.046585601	0.025633456	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2017,0,00	1	1	2017	1	5	7	25	25025	250250	1	106	NULL	0	0	2	2017	0	0	0.0115902	1	0.046585601	0.248793604	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2017,0,00	1	1	2017	1	5	7	25	25025	250250	1	100	NULL	0	0	2	2017	0	0	0.000851936	1	0.046585601	0.018287539	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2017,0,00	1	1	2017	1	5	7	25	25025	250250	1	98	NULL	0	0	2	2017	0	0	47.32360077	1	0.046585601	1015.841804	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2017,0,00	1	1	2017	1	5	7	25	25025	250250	1	91	NULL	0	0	2	2017	0	0	0.000608149	1	0.046585601	0.013054437	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2017,0,00	1	1	2017	1	5	7	25	25025	250250	1	90	NULL	0	0	2	2017	0	0	47.26330185	1	0.046585601	1014.547436	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2017,0,00	1	1	2017	1	5	7	25	25025	250250	1	87	NULL	0	0	2	2017	0	0	0.00224148	1	0.046585601	0.048115295	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2017,0,00	1	1	2017	1	5	7	25	25025	250250	1	79	NULL	0	0	2	2017	0	0	0.00171656	1	0.046585601	0.036847437	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2017,0,00	1	1	2017	1	5	7	25	25025	250250	1	66	NULL	0	0	2	2017	0	0	7.71863E-07	1	0.046585601	1.65687E-05	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2017,0,00	1	1	2017	1	5	7	25	25025	250250	1	59	NULL	0	0	2	2017	0	0	3.49803E-06	1	0.046585601	7.50882E-05	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2017,0,00	1	1	2017	1	5	7	25	25025	250250	1	58	NULL	0	0	2	2017	0	0	5.75102E-07	1	0.046585601	1.23451E-05	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2017,0,00	1	1	2017	1	5	7	25	25025	250250	1	57	NULL	0	0	2	2017	0	0	4.78169E-07	1	0.046585601	1.02643E-05	g	mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2017,0,00	1	1	2017	1	5	7	25	25025	250250	1	56	NULL	0	0	2	2017	0	0	8.94774E-08	1	0.046585601	1.92071E-06	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2017,0,00	1	1	2017	1	5	7	25	25025	250250	1	55	NULL	0	0	2	2017	0	0	2.5633E-06	1	0.046585601	5.50234E-05	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2017,0,00	1	1	2017	1	5	7	25	25025	250250	1	54	NULL	0	0	2	2017	0	0	7.48895E-07	1	0.046585601	1.60757E-05	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2017,0,00	1	1	2017	1	5	7	25	25025	250250	1	53	NULL	0	0	2	2017	0	0	2.57534E-07	1	0.046585601	5.52819E-06	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2017,0,00	1	1	2017	1	5	7	25	25025	250250	1	52	NULL	0	0	2	2017	0	0	5.38356E-06	1	0.046585601	0.000115563	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2017,0,00	1	1	2017	1	5	7	25	25025	250250	1	51	NULL	0	0	2	2017	0	0	2.15281E-07	1	0.046585601	4.62119E-06	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2017,0,00	1	1	2017	1	5	7	25	25025	250250	1	36	NULL	0	0	2	2017	0	0	0	1	0.046585601	0	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2017,0,00	1	1	2017	1	5	7	25	25025	250250	1	35	NULL	0	0	2	2017	0	0	0	1	0.046585601	0	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2017,0,00	1	1	2017	1	5	7	25	25025	250250	1	31	NULL	0	0	2	2017	0	0	0.000394039	1	0.046585601	0.008458386	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2017,0,00	1	1	2017	1	5	7	25	25025	250250	1	5	NULL	0	0	2	2017	0	0	0.00241574	1	0.046585601	0.051855936	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2017,0,00	1	1	2017	1	5	7	25	25025	250250	1	3	NULL	0	0	2	2017	0	0	0.044062998	1	0.046585601	0.945850163	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2017,0,00	1	1	2017	1	5	7	25	25025	250250	1	2	NULL	0	0	2	2017	0	0	0.0127928	1	0.046585601	0.27460845	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2017,0,00	1	1	2017	1	5	7	25	25025	250250	1	1	NULL	0	0	2	2017	0	0	0.0041323	1	0.046585601	0.088703378	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2016,0,00	1	1	2017	1	5	7	25	25025	250250	1	122	NULL	0	0	2	2016	0	0	2.37868E-05	1	0.045457602	0.000523274	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2016,0,00	1	1	2017	1	5	7	25	25025	250250	1	121	NULL	0	0	2	2016	0	0	4.15644E-06	1	0.045457602	9.14355E-05	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2016,0,00	1	1	2017	1	5	7	25	25025	250250	1	119	NULL	0	0	2	2016	0	0	0	1	0.045457602	0	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2016,0,00	1	1	2017	1	5	7	25	25025	250250	1	118	NULL	0	0	2	2016	0	0	0.0006964	1	0.045457602	0.01531977	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2016,0,00	1	1	2017	1	5	7	25	25025	250250	1	117	NULL	0	0	2	2016	0	0	0.000174785	1	0.045457602	0.003845012	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2016,0,00	1	1	2017	1	5	7	25	25025	250250	1	116	NULL	0	0	2	2016	0	0	0.00141371	1	0.045457602	0.031099528	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2016,0,00	1	1	2017	1	5	7	25	25025	250250	1	115	NULL	0	0	2	2016	0	0	0.000536048	1	0.045457602	0.011792264	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2016,0,00	1	1	2017	1	5	7	25	25025	250250	1	112	NULL	0	0	2	2016	0	0	6.84066E-05	1	0.045457602	0.001504844	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2016,0,00	1	1	2017	1	5	7	25	25025	250250	1	111	NULL	0	0	2	2016	0	0	0.000118934	1	0.045457602	0.002616372	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2016,0,00	1	1	2017	1	5	7	25	25025	250250	1	110	NULL	0	0	2	2016	0	0	0.000764807	1	0.045457602	0.016824623	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2016,0,00	1	1	2017	1	5	7	25	25025	250250	1	107	NULL	0	0	2	2016	0	0	0.00116524	1	0.045457602	0.025633556	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2016,0,00	1	1	2017	1	5	7	25	25025	250250	1	106	NULL	0	0	2	2016	0	0	0.0113097	1	0.045457602	0.248796674	g	mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2016,0,00 1 1 2017 1 5 7 25 25025 250250 1 100 NULL 0 0 2 2016 0 0 0.000831314 1 0.045457602 0.018287679 g mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2016,0,00 1 1 2017 1 5 7 25 25025 250250 1 98 NULL 0 0 2 2016 0 0 47.65010071 1 0.045457602 1048.231739 g mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2016,0,00 1 1 2017 1 5 7 25 25025 250250 1 91 NULL 0 0 2 2016 0 0 0.000612369 1 0.045457602 0.013471202 g mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2016,0,00 1 1 2017 1 5 7 25 25025 250250 1 90 NULL 0 0 2 2016 0 0 47.59120178 1 0.045457602 1046.936049 g mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2016,0,00 1 1 2017 1 5 7 25 25025 250250 1 87 NULL 0 0 2 2016 0 0 0.00218723 1 0.045457602 0.048115823 g mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2016,0,00 1 1 2017 1 5 7 25 25025 250250 1 79 NULL 0 0 2 2016 0 0 0.00167501 1 0.045457602 0.036847742 g mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2016,0,00 1 1 2017 1 5 7 25 25025 250250 1 66 NULL 0 0 2 2016 0 0 7.5318E-07 1 0.045457602 1.65688E-05 g mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2016,0,00 1 1 2017 1 5 7 25 25025 250250 1 59 NULL 0 0 2 2016 0 0 3.41336E-06 1 0.045457602 7.50889E-05 g mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2016,0,00 1 1 2017 1 5 7 25 25025 250250 1 58 NULL 0 0 2 2016 0 0 5.61182E-07 1 0.045457602 1.23452E-05 g mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2016,0,00 1 1 2017 1 5 7 25 25025 250250 1 57 NULL 0 0 2 2016 0 0 4.66594E-07 1 0.045457602 1.02644E-05 g mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2016,0,00 1 1 2017 1 5 7 25 25025 250250 1 56 NULL 0 0 2 2016 0 0 8.73115E-08 1 0.045457602 1.92072E-06 g mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2016,0,00 1 1 2017 1 5 7 25 25025 250250 1 55 NULL 0 0 2 2016 0 0 2.50125E-06 1 0.045457602 5.50238E-05 g mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2016,0,00 1 1 2017 1 5 7 25 25025 250250 1 54 NULL 0 0 2 2016 0 0 7.30768E-07 1 0.045457602 1.60758E-05 g mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2016,0,00 1 1 2017 1 5 7 25 25025 250250 1 53 NULL 0 0 2 2016 0 0 2.51301E-07 1 0.045457602 5.52825E-06 g mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2016,0,00 1 1 2017 1 5 7 25 25025 250250 1 52 NULL 0 0 2 2016 0 0 5.25325E-06 1 0.045457602 0.000115564 g mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2016,0,00 1 1 2017 1 5 7 25 25025 250250 1 51 NULL 0 0 2 2016 0 0 2.1007E-07 1 0.045457602 4.62123E-06 g mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2016,0,00 1 1 2017 1 5 7 25 25025 250250 1 36 NULL 0 0 2 2016 0 0 0 1 0.045457602 0 g mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2016,0,00 1 1 2017 1 5 7 25 25025 250250 1 35 NULL 0 0 2 2016 0 0 0 1 0.045457602 0 g mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2016,0,00 1 1 2017 1 5 7 25 25025 250250 1 31 NULL 0 0 2 2016 0 0 0.000396774 1 0.045457602 0.008728441 g mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2016,0,00 1 1 2017 1 5 7 25 25025 250250 1 5 NULL 0 0 2 2016 0 0 0.00235727 1 0.045457602 0.051856456 g mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2016,0,00 1 1 2017 1 5 7 25 25025 250250 1 3 NULL 0 0 2 2016 0 0 0.042996399 1 0.045457602 0.945857187 g mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2016,0,00 1 1 2017 1 5 7 25 25025 250250 1 2 NULL 0 0 2 2016 0 0 0.0124831 1 0.045457602 0.274609746 g mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2016,0,00 1 1 2017 1 5 7 25 25025 250250 1 1 NULL 0 0 2 2016 0 0 0.00403227 1 0.045457602 0.088703977 g mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2015,0,00 1 1 2017 1 5 7 25 25025 250250 1 122 NULL 0 0 2 2015 0 0 6.02211E-05 1 0.115084998 0.000523275 g mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2015,0,00 1 1 2017 1 5 7 25 25025 250250 1 121 NULL 0 0 2 2015 0 0 1.05229E-05 1 0.115084998 9.14359E-05 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2015,0,00	1	1	2017	1	5	7	25	25025	250250	1	119	NULL	0	0	2	2015	0	0	0	1	0.115084998	0	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2015,0,00	1	1	2017	1	5	7	25	25025	250250	1	118	NULL	0	0	2	2015	0	0	0.00176308	1	0.115084998	0.015319807	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2015,0,00	1	1	2017	1	5	7	25	25025	250250	1	117	NULL	0	0	2	2015	0	0	0.000442504	1	0.115084998	0.003845019	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2015,0,00	1	1	2017	1	5	7	25	25025	250250	1	116	NULL	0	0	2	2015	0	0	0.0035791	1	0.115084998	0.031099622	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2015,0,00	1	1	2017	1	5	7	25	25025	250250	1	115	NULL	0	0	2	2015	0	0	0.00135711	1	0.115084998	0.011792241	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2015,0,00	1	1	2017	1	5	7	25	25025	250250	1	112	NULL	0	0	2	2015	0	0	0.000173185	1	0.115084998	0.001504844	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2015,0,00	1	1	2017	1	5	7	25	25025	250250	1	111	NULL	0	0	2	2015	0	0	0.000301106	1	0.115084998	0.002616379	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2015,0,00	1	1	2017	1	5	7	25	25025	250250	1	110	NULL	0	0	2	2015	0	0	0.00193626	1	0.115084998	0.016824608	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2015,0,00	1	1	2017	1	5	7	25	25025	250250	1	107	NULL	0	0	2	2015	0	0	0.00295004	1	0.115084998	0.025633575	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2015,0,00	1	1	2017	1	5	7	25	25025	250250	1	106	NULL	0	0	2	2015	0	0	0.028632799	1	0.115084998	0.248796973	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2015,0,00	1	1	2017	1	5	7	25	25025	250250	1	100	NULL	0	0	2	2015	0	0	0.00210464	1	0.115084998	0.018287701	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2015,0,00	1	1	2017	1	5	7	25	25025	250250	1	98	NULL	0	0	2	2015	0	0	120.6360016	1	0.115084998	1048.233943	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2015,0,00	1	1	2017	1	5	7	25	25025	250250	1	91	NULL	0	0	2	2015	0	0	0.001550335	1	0.115084998	0.013471216	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2015,0,00	1	1	2017	1	5	7	25	25025	250250	1	90	NULL	0	0	2	2015	0	0	120.4869995	1	0.115084998	1046.93923	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2015,0,00	1	1	2017	1	5	7	25	25025	250250	1	87	NULL	0	0	2	2015	0	0	0.0055374	1	0.115084998	0.048115741	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2015,0,00	1	1	2017	1	5	7	25	25025	250250	1	79	NULL	0	0	2	2015	0	0	0.00424062	1	0.115084998	0.036847721	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2015,0,00	1	1	2017	1	5	7	25	25025	250250	1	66	NULL	0	0	2	2015	0	0	1.90683E-06	1	0.115084998	1.65689E-05	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2015,0,00	1	1	2017	1	5	7	25	25025	250250	1	59	NULL	0	0	2	2015	0	0	8.64161E-06	1	0.115084998	7.50889E-05	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2015,0,00	1	1	2017	1	5	7	25	25025	250250	1	58	NULL	0	0	2	2015	0	0	1.42075E-06	1	0.115084998	1.23452E-05	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2015,0,00	1	1	2017	1	5	7	25	25025	250250	1	57	NULL	0	0	2	2015	0	0	1.18128E-06	1	0.115084998	1.02644E-05	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2015,0,00	1	1	2017	1	5	7	25	25025	250250	1	56	NULL	0	0	2	2015	0	0	2.21047E-07	1	0.115084998	1.92073E-06	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2015,0,00	1	1	2017	1	5	7	25	25025	250250	1	55	NULL	0	0	2	2015	0	0	6.33243E-06	1	0.115084998	5.50239E-05	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2015,0,00	1	1	2017	1	5	7	25	25025	250250	1	54	NULL	0	0	2	2015	0	0	1.85009E-06	1	0.115084998	1.60759E-05	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2015,0,00	1	1	2017	1	5	7	25	25025	250250	1	53	NULL	0	0	2	2015	0	0	6.36218E-07	1	0.115084998	5.52824E-06	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2015,0,00	1	1	2017	1	5	7	25	25025	250250	1	52	NULL	0	0	2	2015	0	0	1.32997E-05	1	0.115084998	0.000115564	g	mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2015,0,00 1 1 2017 1 5 7 25 25025 250250 1 51 NULL 0 0 2 2015 0
0 5.31835E-07 1 0.115084998 4.62124E-06 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2015,0,00 1 1 2017 1 5 7 25 25025 250250 1 36 NULL 0 0 2 2015 0
0 0 1 0.115084998 0 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2015,0,00 1 1 2017 1 5 7 25 25025 250250 1 35 NULL 0 0 2 2015 0
0 0 1 0.115084998 0 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2015,0,00 1 1 2017 1 5 7 25 25025 250250 1 31 NULL 0 0 2 2015 0
0 0.00100451 1 0.115084998 0.008728418 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2015,0,00 1 1 2017 1 5 7 25 25025 250250 1 5 NULL 0 0 2 2015 0
0 0.0059679 1 0.115084998 0.051856456 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2015,0,00 1 1 2017 1 5 7 25 25025 250250 1 3 NULL 0 0 2 2015 0
0 0.108854003 1 0.115084998 0.945857452 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2015,0,00 1 1 2017 1 5 7 25 25025 250250 1 2 NULL 0 0 2 2015 0
0 0.031603601 1 0.115084998 0.274610951 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2015,0,00 1 1 2017 1 5 7 25 25025 250250 1 1 NULL 0 0 2 2015 0
0 0.0102085 1 0.115084998 0.088703999 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2014,0,00 1 1 2017 1 5 7 25 25025 250250 1 122 NULL 0 0 2 2014 0
0 8.98821E-06 1 0.017177001 0.00052327 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2014,0,00 1 1 2017 1 5 7 25 25025 250250 1 121 NULL 0 0 2 2014 0
0 1.57057E-06 1 0.017177001 9.14345E-05 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2014,0,00 1 1 2017 1 5 7 25 25025 250250 1 119 NULL 0 0 2 2014 0
0 0 1 0.017177001 0 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2014,0,00 1 1 2017 1 5 7 25 25025 250250 1 118 NULL 0 0 2 2014 0
0 0.000263145 1 0.017177001 0.015319612 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2014,0,00 1 1 2017 1 5 7 25 25025 250250 1 117 NULL 0 0 2 2014 0
0 6.60453E-05 1 0.017177001 0.003844984 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2014,0,00 1 1 2017 1 5 7 25 25025 250250 1 116 NULL 0 0 2 2014 0
0 0.000534193 1 0.017177001 0.031099318 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2014,0,00 1 1 2017 1 5 7 25 25025 250250 1 115 NULL 0 0 2 2014 0
0 0.000202554 1 0.017177001 0.011792164 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2014,0,00 1 1 2017 1 5 7 25 25025 250250 1 112 NULL 0 0 2 2014 0
0 2.58485E-05 1 0.017177001 0.001504832 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2014,0,00 1 1 2017 1 5 7 25 25025 250250 1 111 NULL 0 0 2 2014 0
0 4.4941E-05 1 0.017177001 0.002616347 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2014,0,00 1 1 2017 1 5 7 25 25025 250250 1 110 NULL 0 0 2 2014 0
0 0.000288994 1 0.017177001 0.016824474 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2014,0,00 1 1 2017 1 5 7 25 25025 250250 1 107 NULL 0 0 2 2014 0
0 0.000440304 1 0.017177001 0.025633346 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2014,0,00 1 1 2017 1 5 7 25 25025 250250 1 106 NULL 0 0 2 2014 0
0 0.00427354 1 0.017177001 0.248794301 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2014,0,00 1 1 2017 1 5 7 25 25025 250250 1 100 NULL 0 0 2 2014 0
0 0.000314125 1 0.017177001 0.018287535 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2014,0,00 1 1 2017 1 5 7 25 25025 250250 1 98 NULL 0 0 2 2014 0
0 18.00530052 1 0.017177001 1048.22145 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2014,0,00 1 1 2017 1 5 7 25 25025 250250 1 91 NULL 0 0 2 2014 0
0 0.000231392 1 0.017177001 0.013471064 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2014,0,00 1 1 2017 1 5 7 25 25025 250250 1 90 NULL 0 0 2 2014 0
0 17.98310089 1 0.017177001 1046.929046 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2014,0,00 1 1 2017 1 5 7 25 25025 250250 1 87 NULL 0 0 2 2014 0
0 0.000826476 1 0.017177001 0.04811527 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2014,0,00 1 1 2017 1 5 7 25 25025 250250 1 79 NULL 0 0 2 2014 0 0 0.000632927 1 0.017177001 0.036847352 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2014,0,00 1 1 2017 1 5 7 25 25025 250250 1 66 NULL 0 0 2 2014 0 0 2.84601E-07 1 0.017177001 1.65687E-05 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2014,0,00 1 1 2017 1 5 7 25 25025 250250 1 59 NULL 0 0 2 2014 0 0 1.28979E-06 1 0.017177001 7.50882E-05 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2014,0,00 1 1 2017 1 5 7 25 25025 250250 1 58 NULL 0 0 2 2014 0 0 2.12051E-07 1 0.017177001 1.23451E-05 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2014,0,00 1 1 2017 1 5 7 25 25025 250250 1 57 NULL 0 0 2 2014 0 0 1.7631E-07 1 0.017177001 1.02643E-05 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2014,0,00 1 1 2017 1 5 7 25 25025 250250 1 56 NULL 0 0 2 2014 0 0 3.2992E-08 1 0.017177001 1.92071E-06 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2014,0,00 1 1 2017 1 5 7 25 25025 250250 1 55 NULL 0 0 2 2014 0 0 9.45136E-07 1 0.017177001 5.50233E-05 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2014,0,00 1 1 2017 1 5 7 25 25025 250250 1 54 NULL 0 0 2 2014 0 0 2.76132E-07 1 0.017177001 1.60757E-05 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2014,0,00 1 1 2017 1 5 7 25 25025 250250 1 53 NULL 0 0 2 2014 0 0 9.49578E-08 1 0.017177001 5.52819E-06 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2014,0,00 1 1 2017 1 5 7 25 25025 250250 1 52 NULL 0 0 2 2014 0 0 1.98502E-06 1 0.017177001 0.000115563 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2014,0,00 1 1 2017 1 5 7 25 25025 250250 1 51 NULL 0 0 2 2014 0 0 7.93782E-08 1 0.017177001 4.62119E-06 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2014,0,00 1 1 2017 1 5 7 25 25025 250250 1 36 NULL 0 0 2 2014 0 0 0 1 0.017177001 0 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2014,0,00 1 1 2017 1 5 7 25 25025 250250 1 35 NULL 0 0 2 2014 0 0 0 1 0.017177001 0 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2014,0,00 1 1 2017 1 5 7 25 25025 250250 1 31 NULL 0 0 2 2014 0 0 0.000149927 1 0.017177001 0.008728357 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2014,0,00 1 1 2017 1 5 7 25 25025 250250 1 5 NULL 0 0 2 2014 0 0 0.000890729 1 0.017177001 0.051855911 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2014,0,00 1 1 2017 1 5 7 25 25025 250250 1 3 NULL 0 0 2 2014 0 0 0.0162469 1 0.017177001 0.945851974 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2014,0,00 1 1 2017 1 5 7 25 25025 250250 1 2 NULL 0 0 2 2014 0 0 0.00471694 1 0.017177001 0.274607909 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2014,0,00 1 1 2017 1 5 7 25 25025 250250 1 1 NULL 0 0 2 2014 0 0 0.00152366 1 0.017177001 0.088703497 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2013,0,00 1 1 2017 1 5 7 25 25025 250250 1 122 NULL 0 0 2 2013 0 0 1.23855E-05 1 0.020039801 0.000618045 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2013,0,00 1 1 2017 1 5 7 25 25025 250250 1 121 NULL 0 0 2 2013 0 0 2.1642E-06 1 0.020039801 0.000107995 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2013,0,00 1 1 2017 1 5 7 25 25025 250250 1 119 NULL 0 0 2 2013 0 0 0 1 0.020039801 0 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2013,0,00 1 1 2017 1 5 7 25 25025 250250 1 118 NULL 0 0 2 2013 0 0 0.000362606 1 0.020039801 0.018094291 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2013,0,00 1 1 2017 1 5 7 25 25025 250250 1 117 NULL 0 0 2 2013 0 0 7.7053E-05 1 0.020039801 0.003844998 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2013,0,00 1 1 2017 1 5 7 25 25025 250250 1 116 NULL 0 0 2 2013 0 0 0.000623226 1 0.020039801 0.031099411 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2013,0,00 1 1 2017 1 5 7 25 25025 250250 1 115 NULL 0 0 2 2013 0 0 0.000279112 1 0.020039801 0.013927883 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2013,0,00 1 1 2017 1 5 7 25 25025 250250 1 112 NULL 0 0 2 2013 0 0 3.56182E-05 1 0.020039801 0.001777373 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2013,0,00 1 1 2017 1 5 7 25 25025 250250 1 111 NULL 0 0 2 2013 0 0 6.19273E-05 1 0.020039801 0.003090215 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2013,0,00 1 1 2017 1 5 7 25 25025 250250 1 110 NULL 0 0 2 2013 0 0 0.000398224 1 0.020039801 0.019871654 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2013,0,00 1 1 2017 1 5 7 25 25025 250250 1 107 NULL 0 0 2 2013 0 0 0.000513689 1 0.020039801 0.025633439 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2013,0,00 1 1 2017 1 5 7 25 25025 250250 1 106 NULL 0 0 2 2013 0 0 0.00498581 1 0.020039801 0.24879538 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2013,0,00 1 1 2017 1 5 7 25 25025 250250 1 100 NULL 0 0 2 2013 0 0 0.000432853 1 0.020039801 0.021599666 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2013,0,00 1 1 2017 1 5 7 25 25025 250250 1 98 NULL 0 0 2 2013 0 0 21.65679932 1 0.020039801 1080.689364 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2013,0,00 1 1 2017 1 5 7 25 25025 250250 1 91 NULL 0 0 2 2013 0 0 0.000278308 1 0.020039801 0.013887788 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2013,0,00 1 1 2017 1 5 7 25 25025 250250 1 90 NULL 0 0 2 2013 0 0 21.62919998 1 0.020039801 1079.312138 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2013,0,00 1 1 2017 1 5 7 25 25025 250250 1 87 NULL 0 0 2 2013 0 0 0.00102377 1 0.020039801 0.051086834 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2013,0,00 1 1 2017 1 5 7 25 25025 250250 1 79 NULL 0 0 2 2013 0 0 0.000784018 1 0.020039801 0.039123045 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2013,0,00 1 1 2017 1 5 7 25 25025 250250 1 66 NULL 0 0 2 2013 0 0 3.32034E-07 1 0.020039801 1.65687E-05 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2013,0,00 1 1 2017 1 5 7 25 25025 250250 1 59 NULL 0 0 2 2013 0 0 1.77729E-06 1 0.020039801 8.8688E-05 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2013,0,00 1 1 2017 1 5 7 25 25025 250250 1 58 NULL 0 0 2 2013 0 0 2.922E-07 1 0.020039801 1.4581E-05 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2013,0,00 1 1 2017 1 5 7 25 25025 250250 1 57 NULL 0 0 2 2013 0 0 2.42949E-07 1 0.020039801 1.21233E-05 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2013,0,00 1 1 2017 1 5 7 25 25025 250250 1 56 NULL 0 0 2 2013 0 0 4.54619E-08 1 0.020039801 2.26858E-06 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2013,0,00 1 1 2017 1 5 7 25 25025 250250 1 55 NULL 0 0 2 2013 0 0 1.30237E-06 1 0.020039801 6.49892E-05 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2013,0,00 1 1 2017 1 5 7 25 25025 250250 1 54 NULL 0 0 2 2013 0 0 3.805E-07 1 0.020039801 1.89872E-05 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2013,0,00 1 1 2017 1 5 7 25 25025 250250 1 53 NULL 0 0 2 2013 0 0 1.30849E-07 1 0.020039801 6.52946E-06 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2013,0,00 1 1 2017 1 5 7 25 25025 250250 1 52 NULL 0 0 2 2013 0 0 2.73529E-06 1 0.020039801 0.000136493 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2013,0,00 1 1 2017 1 5 7 25 25025 250250 1 51 NULL 0 0 2 2013 0 0 1.09381E-07 1 0.020039801 5.45819E-06 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2013,0,00 1 1 2017 1 5 7 25 25025 250250 1 36 NULL 0 0 2 2013 0 0 0 1 0.020039801 0 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2013,0,00 1 1 2017 1 5 7 25 25025 250250 1 35 NULL 0 0 2 2013 0 0 0 1 0.020039801 0 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2013,0,00 1 1 2017 1 5 7 25 25025 250250 1 31 NULL 0 0 2 2013 0 0 0.000180325 1 0.020039801 0.008998343 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2013,0,00 1 1 2017 1 5 7 25 25025 250250 1 5 NULL 0 0 2 2013 0 0 0.00110336 1 0.020039801 0.055058431 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2013,0,00	1	1	2017	1	5	7	25	25025	250250	1	3	NULL	0	0	2	2013	0	0	0.022006599	1	0.020039801	1.098144623	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2013,0,00	1	1	2017	1	5	7	25	25025	250250	1	2	NULL	0	0	2	2013	0	0	0.00584296	1	0.020039801	0.291567771	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2013,0,00	1	1	2017	1	5	7	25	25025	250250	1	1	NULL	0	0	2	2013	0	0	0.00188738	1	0.020039801	0.094181578	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2012,0,00	1	1	2017	1	5	7	25	25025	250250	1	122	NULL	0	0	2	2012	0	0	1.04343E-05	1	0.015945099	0.000654389	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2012,0,00	1	1	2017	1	5	7	25	25025	250250	1	121	NULL	0	0	2	2012	0	0	1.82327E-06	1	0.015945099	0.000114347	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2012,0,00	1	1	2017	1	5	7	25	25025	250250	1	119	NULL	0	0	2	2012	0	0	0	1	0.015945099	0	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2012,0,00	1	1	2017	1	5	7	25	25025	250250	1	118	NULL	0	0	2	2012	0	0	0.000305483	1	0.015945099	0.019158426	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2012,0,00	1	1	2017	1	5	7	25	25025	250250	1	117	NULL	0	0	2	2012	0	0	6.13091E-05	1	0.015945099	0.003845012	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2012,0,00	1	1	2017	1	5	7	25	25025	250250	1	116	NULL	0	0	2	2012	0	0	0.000495885	1	0.015945099	0.031099523	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2012,0,00	1	1	2017	1	5	7	25	25025	250250	1	115	NULL	0	0	2	2012	0	0	0.000235143	1	0.015945099	0.014747039	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2012,0,00	1	1	2017	1	5	7	25	25025	250250	1	112	NULL	0	0	2	2012	0	0	3.00072E-05	1	0.015945099	0.001881907	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2012,0,00	1	1	2017	1	5	7	25	25025	250250	1	111	NULL	0	0	2	2012	0	0	5.21717E-05	1	0.015945099	0.003271958	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2012,0,00	1	1	2017	1	5	7	25	25025	250250	1	110	NULL	0	0	2	2012	0	0	0.00033549	1	0.015945099	0.021040321	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2012,0,00	1	1	2017	1	5	7	25	25025	250250	1	107	NULL	0	0	2	2012	0	0	0.000408729	1	0.015945099	0.02563352	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2012,0,00	1	1	2017	1	5	7	25	25025	250250	1	106	NULL	0	0	2	2012	0	0	0.00396708	1	0.015945099	0.24879618	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2012,0,00	1	1	2017	1	5	7	25	25025	250250	1	100	NULL	0	0	2	2012	0	0	0.000364665	1	0.015945099	0.022870036	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2012,0,00	1	1	2017	1	5	7	25	25025	250250	1	98	NULL	0	0	2	2012	0	0	17.23220062	1	0.015945099	1080.72081	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2012,0,00	1	1	2017	1	5	7	25	25025	250250	1	91	NULL	0	0	2	2012	0	0	0.000221443	1	0.015945099	0.013887855	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2012,0,00	1	1	2017	1	5	7	25	25025	250250	1	90	NULL	0	0	2	2012	0	0	17.20980072	1	0.015945099	1079.315996	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2012,0,00	1	1	2017	1	5	7	25	25025	250250	1	87	NULL	0	0	2	2012	0	0	0.000831964	1	0.015945099	0.052176785	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2012,0,00	1	1	2017	1	5	7	25	25025	250250	1	79	NULL	0	0	2	2012	0	0	0.00063713	1	0.015945099	0.039957732	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2012,0,00	1	1	2017	1	5	7	25	25025	250250	1	66	NULL	0	0	2	2012	0	0	2.64191E-07	1	0.015945099	1.65688E-05	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2012,0,00	1	1	2017	1	5	7	25	25025	250250	1	59	NULL	0	0	2	2012	0	0	1.49731E-06	1	0.015945099	9.39041E-05	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2012,0,00	1	1	2017	1	5	7	25	25025	250250	1	58	NULL	0	0	2	2012	0	0	2.46168E-07	1	0.015945099	1.54385E-05	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2012,0,00	1	1	2017	1	5	7	25	25025	250250	1	57	NULL	0	0	2	2012	0	0	2.04677E-07	1	0.015945099	1.28364E-05	g	mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2012,0,00 1 1 2017 1 5 7 25 25025 250250 1 56 NULL 0 0 2 2012 0 0 3.83001E-08 1 0.015945099 2.402E-06 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2012,0,00 1 1 2017 1 5 7 25 25025 250250 1 55 NULL 0 0 2 2012 0 0 1.0972E-06 1 0.015945099 6.88111E-05 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2012,0,00 1 1 2017 1 5 7 25 25025 250250 1 54 NULL 0 0 2 2012 0 0 3.20559E-07 1 0.015945099 2.01039E-05 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2012,0,00 1 1 2017 1 5 7 25 25025 250250 1 53 NULL 0 0 2 2012 0 0 1.10236E-07 1 0.015945099 6.91347E-06 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2012,0,00 1 1 2017 1 5 7 25 25025 250250 1 52 NULL 0 0 2 2012 0 0 2.30439E-06 1 0.015945099 0.00014452 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2012,0,00 1 1 2017 1 5 7 25 25025 250250 1 51 NULL 0 0 2 2012 0 0 9.21495E-08 1 0.015945099 5.77917E-06 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2012,0,00 1 1 2017 1 5 7 25 25025 250250 1 36 NULL 0 0 2 2012 0 0 0 1 0.015945099 0 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2012,0,00 1 1 2017 1 5 7 25 25025 250250 1 35 NULL 0 0 2 2012 0 0 0 1 0.015945099 0 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2012,0,00 1 1 2017 1 5 7 25 25025 250250 1 31 NULL 0 0 2 2012 0 0 0.00014348 1 0.015945099 0.008998377 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2012,0,00 1 1 2017 1 5 7 25 25025 250250 1 5 NULL 0 0 2 2012 0 0 0.000896644 1 0.015945099 0.056233204 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2012,0,00 1 1 2017 1 5 7 25 25025 250250 1 3 NULL 0 0 2 2012 0 0 0.018400401 1 0.015945099 1.153984716 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2012,0,00 1 1 2017 1 5 7 25 25025 250250 1 2 NULL 0 0 2 2012 0 0 0.00474826 1 0.015945099 0.297788057 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2012,0,00 1 1 2017 1 5 7 25 25025 250250 1 1 NULL 0 0 2 2012 0 0 0.00153377 1 0.015945099 0.096190684 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2011,0,00 1 1 2017 1 5 7 25 25025 250250 1 122 NULL 0 0 2 2011 0 0 1.33517E-05 1 0.017496999 0.000763085 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2011,0,00 1 1 2017 1 5 7 25 25025 250250 1 121 NULL 0 0 2 2011 0 0 2.33304E-06 1 0.017496999 0.000133339 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2011,0,00 1 1 2017 1 5 7 25 25025 250250 1 119 NULL 0 0 2 2011 0 0 0 1 0.017496999 0 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2011,0,00 1 1 2017 1 5 7 25 25025 250250 1 118 NULL 0 0 2 2011 0 0 0.000390894 1 0.017496999 0.022340631 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2011,0,00 1 1 2017 1 5 7 25 25025 250250 1 117 NULL 0 0 2 2011 0 0 6.72758E-05 1 0.017496999 0.003844991 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2011,0,00 1 1 2017 1 5 7 25 25025 250250 1 116 NULL 0 0 2 2011 0 0 0.000544146 1 0.017496999 0.031099389 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2011,0,00 1 1 2017 1 5 7 25 25025 250250 1 115 NULL 0 0 2 2011 0 0 0.000300887 1 0.017496999 0.017196492 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2011,0,00 1 1 2017 1 5 7 25 25025 250250 1 112 NULL 0 0 2 2011 0 0 3.83969E-05 1 0.017496999 0.002194485 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2011,0,00 1 1 2017 1 5 7 25 25025 250250 1 111 NULL 0 0 2 2011 0 0 6.67584E-05 1 0.017496999 0.00381542 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2011,0,00 1 1 2017 1 5 7 25 25025 250250 1 110 NULL 0 0 2 2011 0 0 0.000429291 1 0.017496999 0.02453512 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2011,0,00 1 1 2017 1 5 7 25 25025 250250 1 107 NULL 0 0 2 2011 0 0 0.000448508 1 0.017496999 0.025633425 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2011,0,00 1 1 2017 1 5 7 25 25025 250250 1 106 NULL 0 0 2 2011 0 0 0.00435317 1 0.017496999 0.248795221 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2011,0,00 1 1 2017 1 5 7 25 25025 250250 1 100 NULL 0 0 2 2011 0 0 0.000466622 1 0.017496999 0.026668687 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2011,0,00 1 1 2017 1 5 7 25 25025 250250 1 98 NULL 0 0 2 2011 0 0 18.91090012 1 0.017496999 1080.808185 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2011,0,00 1 1 2017 1 5 7 25 25025 250250 1 91 NULL 0 0 2 2011 0 0 0.000242994 1 0.017496999 0.01388774 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2011,0,00 1 1 2017 1 5 7 25 25025 250250 1 90 NULL 0 0 2 2011 0 0 18.88470078 1 0.017496999 1079.310823 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2011,0,00 1 1 2017 1 5 7 25 25025 250250 1 87 NULL 0 0 2 2011 0 0 0.000974399 1 0.017496999 0.055689491 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2011,0,00 1 1 2017 1 5 7 25 25025 250250 1 79 NULL 0 0 2 2011 0 0 0.000746209 1 0.017496999 0.042647827 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2011,0,00 1 1 2017 1 5 7 25 25025 250250 1 66 NULL 0 0 2 2011 0 0 2.89903E-07 1 0.017496999 1.65687E-05 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2011,0,00 1 1 2017 1 5 7 25 25025 250250 1 59 NULL 0 0 2 2011 0 0 1.91594E-06 1 0.017496999 0.000109501 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2011,0,00 1 1 2017 1 5 7 25 25025 250250 1 58 NULL 0 0 2 2011 0 0 3.14995E-07 1 0.017496999 1.80028E-05 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2011,0,00 1 1 2017 1 5 7 25 25025 250250 1 57 NULL 0 0 2 2011 0 0 2.61902E-07 1 0.017496999 1.49684E-05 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2011,0,00 1 1 2017 1 5 7 25 25025 250250 1 56 NULL 0 0 2 2011 0 0 4.90085E-08 1 0.017496999 2.80097E-06 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2011,0,00 1 1 2017 1 5 7 25 25025 250250 1 55 NULL 0 0 2 2011 0 0 1.40397E-06 1 0.017496999 8.02406E-05 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2011,0,00 1 1 2017 1 5 7 25 25025 250250 1 54 NULL 0 0 2 2011 0 0 4.10185E-07 1 0.017496999 2.34432E-05 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2011,0,00 1 1 2017 1 5 7 25 25025 250250 1 53 NULL 0 0 2 2011 0 0 1.41057E-07 1 0.017496999 8.06178E-06 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2011,0,00 1 1 2017 1 5 7 25 25025 250250 1 52 NULL 0 0 2 2011 0 0 2.94868E-06 1 0.017496999 0.000168525 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2011,0,00 1 1 2017 1 5 7 25 25025 250250 1 51 NULL 0 0 2 2011 0 0 1.17914E-07 1 0.017496999 6.7391E-06 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2011,0,00 1 1 2017 1 5 7 25 25025 250250 1 36 NULL 0 0 2 2011 0 0 0 1 0.017496999 0 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2011,0,00 1 1 2017 1 5 7 25 25025 250250 1 35 NULL 0 0 2 2011 0 0 0 1 0.017496999 0 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2011,0,00 1 1 2017 1 5 7 25 25025 250250 1 31 NULL 0 0 2 2011 0 0 0.000157444 1 0.017496999 0.008998343 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2011,0,00 1 1 2017 1 5 7 25 25025 250250 1 5 NULL 0 0 2 2011 0 0 0.00105015 1 0.017496999 0.060018864 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2011,0,00 1 1 2017 1 5 7 25 25025 250250 1 3 NULL 0 0 2 2011 0 0 0.023341401 1 0.017496999 1.334023056 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2011,0,00 1 1 2017 1 5 7 25 25025 250250 1 2 NULL 0 0 2 2011 0 0 0.00556116 1 0.017496999 0.317835065 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2011,0,00 1 1 2017 1 5 7 25 25025 250250 1 1 NULL 0 0 2 2011 0 0 0.00179636 1 0.017496999 0.102666747 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2010,0,00 1 1 2017 1 5 7 25 25025 250250 1 122 NULL 0 0 2 2010 0 0 2.32481E-05 1 0.030465901 0.000763086 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2010,0,00 1 1 2017 1 5 7 25 25025 250250 1 121 NULL 0 0 2 2010 0 0 4.06231E-06 1 0.030465901 0.00013334 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2010,0,00	1	1	2017	1	5	7	25	25025	250250	1	119	NULL	0	0	2	2010	0	0	0	1	0.030465901	0	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2010,0,00	1	1	2017	1	5	7	25	25025	250250	1	118	NULL	0	0	2	2010	0	0	0.000680629	1	0.030465901	0.022340682	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2010,0,00	1	1	2017	1	5	7	25	25025	250250	1	117	NULL	0	0	2	2010	0	0	0.000117142	1	0.030465901	0.00384502	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2010,0,00	1	1	2017	1	5	7	25	25025	250250	1	116	NULL	0	0	2	2010	0	0	0.000947476	1	0.030465901	0.031099557	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2010,0,00	1	1	2017	1	5	7	25	25025	250250	1	115	NULL	0	0	2	2010	0	0	0.000523908	1	0.030465901	0.017196537	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2010,0,00	1	1	2017	1	5	7	25	25025	250250	1	112	NULL	0	0	2	2010	0	0	6.68574E-05	1	0.030465901	0.002194499	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2010,0,00	1	1	2017	1	5	7	25	25025	250250	1	111	NULL	0	0	2	2010	0	0	0.000116241	1	0.030465901	0.003815446	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2010,0,00	1	1	2017	1	5	7	25	25025	250250	1	110	NULL	0	0	2	2010	0	0	0.000747486	1	0.030465901	0.024535169	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2010,0,00	1	1	2017	1	5	7	25	25025	250250	1	107	NULL	0	0	2	2010	0	0	0.000780949	1	0.030465901	0.025633544	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2010,0,00	1	1	2017	1	5	7	25	25025	250250	1	106	NULL	0	0	2	2010	0	0	0.00757981	1	0.030465901	0.248796516	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2010,0,00	1	1	2017	1	5	7	25	25025	250250	1	100	NULL	0	0	2	2010	0	0	0.000812488	1	0.030465901	0.026668767	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2010,0,00	1	1	2017	1	5	7	25	25025	250250	1	98	NULL	0	0	2	2010	0	0	32.92789841	1	0.030465901	1080.811577	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2010,0,00	1	1	2017	1	5	7	25	25025	250250	1	91	NULL	0	0	2	2010	0	0	0.000423105	1	0.030465901	0.013887808	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2010,0,00	1	1	2017	1	5	7	25	25025	250250	1	90	NULL	0	0	2	2010	0	0	32.88219833	1	0.030465901	1079.311537	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2010,0,00	1	1	2017	1	5	7	25	25025	250250	1	87	NULL	0	0	2	2010	0	0	0.00169664	1	0.030465901	0.055689804	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2010,0,00	1	1	2017	1	5	7	25	25025	250250	1	79	NULL	0	0	2	2010	0	0	0.00129931	1	0.030465901	0.042648009	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2010,0,00	1	1	2017	1	5	7	25	25025	250250	1	66	NULL	0	0	2	2010	0	0	5.04783E-07	1	0.030465901	1.65688E-05	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2010,0,00	1	1	2017	1	5	7	25	25025	250250	1	59	NULL	0	0	2	2010	0	0	3.33606E-06	1	0.030465901	0.000109501	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2010,0,00	1	1	2017	1	5	7	25	25025	250250	1	58	NULL	0	0	2	2010	0	0	5.48473E-07	1	0.030465901	1.80028E-05	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2010,0,00	1	1	2017	1	5	7	25	25025	250250	1	57	NULL	0	0	2	2010	0	0	4.56028E-07	1	0.030465901	1.49685E-05	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2010,0,00	1	1	2017	1	5	7	25	25025	250250	1	56	NULL	0	0	2	2010	0	0	8.53342E-08	1	0.030465901	2.80097E-06	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2010,0,00	1	1	2017	1	5	7	25	25025	250250	1	55	NULL	0	0	2	2010	0	0	2.44461E-06	1	0.030465901	8.02409E-05	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2010,0,00	1	1	2017	1	5	7	25	25025	250250	1	54	NULL	0	0	2	2010	0	0	7.14218E-07	1	0.030465901	2.34432E-05	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2010,0,00	1	1	2017	1	5	7	25	25025	250250	1	53	NULL	0	0	2	2010	0	0	2.45609E-07	1	0.030465901	8.06177E-06	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2010,0,00	1	1	2017	1	5	7	25	25025	250250	1	52	NULL	0	0	2	2010	0	0	5.13428E-06	1	0.030465901	0.000168525	g	mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2010,0,00 1 1 2017 1 5 7 25 25025 250250 1 51 NULL 0 0 2 2010 0 0 2.05313E-07 1 0.030465901 6.73911E-06 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2010,0,00 1 1 2017 1 5 7 25 25025 250250 1 36 NULL 0 0 2 2010 0 0 0 1 0.030465901 0 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2010,0,00 1 1 2017 1 5 7 25 25025 250250 1 35 NULL 0 0 2 2010 0 0 0 1 0.030465901 0 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2010,0,00 1 1 2017 1 5 7 25 25025 250250 1 31 NULL 0 0 2 2010 0 0 0.000274143 1 0.030465901 0.008998356 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2010,0,00 1 1 2017 1 5 7 25 25025 250250 1 5 NULL 0 0 2 2010 0 0 0.00182855 1 0.030465901 0.060019561 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2010,0,00 1 1 2017 1 5 7 25 25025 250250 1 3 NULL 0 0 2 2010 0 0 0.040642399 1 0.030465901 1.334029132 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2010,0,00 1 1 2017 1 5 7 25 25025 250250 1 2 NULL 0 0 2 2010 0 0 0.00968322 1 0.030465901 0.317837958 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2010,0,00 1 1 2017 1 5 7 25 25025 250250 1 1 NULL 0 0 2 2010 0 0 0.00312785 1 0.030465901 0.102667238 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2009,0,00 1 1 2017 1 5 7 25 25025 250250 1 122 NULL 0 0 2 2009 0 0 2.30509E-05 1 0.024857501 0.000927322 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2009,0,00 1 1 2017 1 5 7 25 25025 250250 1 121 NULL 0 0 2 2009 0 0 4.02784E-06 1 0.024857501 0.000162037 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2009,0,00 1 1 2017 1 5 7 25 25025 250250 1 119 NULL 0 0 2 2009 0 0 0 1 0.024857501 0 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2009,0,00 1 1 2017 1 5 7 25 25025 250250 1 118 NULL 0 0 2 2009 0 0 0.000674854 1 0.024857501 0.027148907 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2009,0,00 1 1 2017 1 5 7 25 25025 250250 1 117 NULL 0 0 2 2009 0 0 9.5577E-05 1 0.024857501 0.003844996 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2009,0,00 1 1 2017 1 5 7 25 25025 250250 1 116 NULL 0 0 2 2009 0 0 0.000773055 1 0.024857501 0.031099467 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2009,0,00 1 1 2017 1 5 7 25 25025 250250 1 115 NULL 0 0 2 2009 0 0 0.000519463 1 0.024857501 0.020897635 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2009,0,00 1 1 2017 1 5 7 25 25025 250250 1 112 NULL 0 0 2 2009 0 0 6.62898E-05 1 0.024857501 0.002666793 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2009,0,00 1 1 2017 1 5 7 25 25025 250250 1 111 NULL 0 0 2 2009 0 0 0.000115254 1 0.024857501 0.004636588 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2009,0,00 1 1 2017 1 5 7 25 25025 250250 1 110 NULL 0 0 2 2009 0 0 0.000741144 1 0.024857501 0.029815709 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2009,0,00 1 1 2017 1 5 7 25 25025 250250 1 107 NULL 0 0 2 2009 0 0 0.000637183 1 0.024857501 0.025633431 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2009,0,00 1 1 2017 1 5 7 25 25025 250250 1 106 NULL 0 0 2 2009 0 0 0.00618444 1 0.024857501 0.248795734 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2009,0,00 1 1 2017 1 5 7 25 25025 250250 1 100 NULL 0 0 2 2009 0 0 0.000805594 1 0.024857501 0.032408489 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2009,0,00 1 1 2017 1 5 7 25 25025 250250 1 98 NULL 0 0 2 2009 0 0 26.89749908 1 0.024857501 1082.067725 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2009,0,00 1 1 2017 1 5 7 25 25025 250250 1 91 NULL 0 0 2 2009 0 0 0.000345216 1 0.024857501 0.013887793 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2009,0,00 1 1 2017 1 5 7 25 25025 250250 1 90 NULL 0 0 2 2009 0 0 26.82900047 1 0.024857501 1079.312073 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2009,0,00 1 1 2017 1 5 7 25 25025 250250 1 87 NULL 0 0 2 2009 0 0 0.00254344 1 0.024857501 0.10232083 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2009,0,00 1 1 2017 1 5 7 25 25025 250250 1 79 NULL 0 0 2 2009 0
0 0.0019478 1 0.024857501 0.078358644 g mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2009,0,00 1 1 2017 1 5 7 25 25025 250250 1 66 NULL 0 0 2 2009 0
0 4.11858E-07 1 0.024857501 1.65688E-05 g mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2009,0,00 1 1 2017 1 5 7 25 25025 250250 1 59 NULL 0 0 2 2009 0
0 3.30775E-06 1 0.024857501 0.000133068 g mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2009,0,00 1 1 2017 1 5 7 25 25025 250250 1 58 NULL 0 0 2 2009 0
0 5.43819E-07 1 0.024857501 2.18775E-05 g mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2009,0,00 1 1 2017 1 5 7 25 25025 250250 1 57 NULL 0 0 2 2009 0
0 4.52158E-07 1 0.024857501 1.819E-05 g mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2009,0,00 1 1 2017 1 5 7 25 25025 250250 1 56 NULL 0 0 2 2009 0
0 8.46102E-08 1 0.024857501 3.40381E-06 g mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2009,0,00 1 1 2017 1 5 7 25 25025 250250 1 55 NULL 0 0 2 2009 0
0 2.42386E-06 1 0.024857501 9.75102E-05 g mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2009,0,00 1 1 2017 1 5 7 25 25025 250250 1 54 NULL 0 0 2 2009 0
0 7.08158E-07 1 0.024857501 2.84887E-05 g mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2009,0,00 1 1 2017 1 5 7 25 25025 250250 1 53 NULL 0 0 2 2009 0
0 2.43525E-07 1 0.024857501 9.79684E-06 g mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2009,0,00 1 1 2017 1 5 7 25 25025 250250 1 52 NULL 0 0 2 2009 0
0 5.09071E-06 1 0.024857501 0.000204796 g mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2009,0,00 1 1 2017 1 5 7 25 25025 250250 1 51 NULL 0 0 2 2009 0
0 2.03571E-07 1 0.024857501 8.18952E-06 g mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2009,0,00 1 1 2017 1 5 7 25 25025 250250 1 36 NULL 0 0 2 2009 0
0 0 1 0.024857501 0 g mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2009,0,00 1 1 2017 1 5 7 25 25025 250250 1 35 NULL 0 0 2 2009 0
0 0 1 0.024857501 0 g mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2009,0,00 1 1 2017 1 5 7 25 25025 250250 1 31 NULL 0 0 2 2009 0
0 0.000223677 1 0.024857501 0.00899837 g mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2009,0,00 1 1 2017 1 5 7 25 25025 250250 1 5 NULL 0 0 2 2009 0
0 0.00274118 1 0.024857501 0.110275765 g mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2009,0,00 1 1 2017 1 5 7 25 25025 250250 1 3 NULL 0 0 2 2009 0
0 0.115455002 1 0.024857501 4.644674603 g mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2009,0,00 1 1 2017 1 5 7 25 25025 250250 1 2 NULL 0 0 2 2009 0
0 0.0145162 1 0.024857501 0.583976651 g mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2009,0,00 1 1 2017 1 5 7 25 25025 250250 1 1 NULL 0 0 2 2009 0
0 0.00468899 1 0.024857501 0.188634808 g mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2008,0,00 1 1 2017 1 5 7 25 25025 250250 1 122 NULL 0 0 2 2008 0
0 2.0454E-05 1 0.022057001 0.000927325 g mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2008,0,00 1 1 2017 1 5 7 25 25025 250250 1 121 NULL 0 0 2 2008 0
0 3.57407E-06 1 0.022057001 0.000162038 g mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2008,0,00 1 1 2017 1 5 7 25 25025 250250 1 119 NULL 0 0 2 2008 0
0 0 1 0.022057001 0 g mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2008,0,00 1 1 2017 1 5 7 25 25025 250250 1 118 NULL 0 0 2 2008 0
0 0.000598825 1 0.022057001 0.027148977 g mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2008,0,00 1 1 2017 1 5 7 25 25025 250250 1 117 NULL 0 0 2 2008 0
0 8.48094E-05 1 0.022057001 0.00384501 g mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2008,0,00 1 1 2017 1 5 7 25 25025 250250 1 116 NULL 0 0 2 2008 0
0 0.000685963 1 0.022057001 0.031099561 g mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2008,0,00 1 1 2017 1 5 7 25 25025 250250 1 115 NULL 0 0 2 2008 0
0 0.00046094 1 0.022057001 0.020897674 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2008,0,00 1 1 2017 1 5 7 25 25025 250250 1 112 NULL 0 0 2 2008 0 0 5.88218E-05 1 0.022057001 0.002666809 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2008,0,00 1 1 2017 1 5 7 25 25025 250250 1 111 NULL 0 0 2 2008 0 0 0.00010227 1 0.022057001 0.004636623 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2008,0,00 1 1 2017 1 5 7 25 25025 250250 1 110 NULL 0 0 2 2008 0 0 0.000657647 1 0.022057001 0.029815794 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2008,0,00 1 1 2017 1 5 7 25 25025 250250 1 107 NULL 0 0 2 2008 0 0 0.000565399 1 0.022057001 0.02563354 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2008,0,00 1 1 2017 1 5 7 25 25025 250250 1 106 NULL 0 0 2 2008 0 0 0.00548771 1 0.022057001 0.248796737 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2008,0,00 1 1 2017 1 5 7 25 25025 250250 1 100 NULL 0 0 2 2008 0 0 0.000714836 1 0.022057001 0.032408577 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2008,0,00 1 1 2017 1 5 7 25 25025 250250 1 98 NULL 0 0 2 2008 0 0 23.86720085 1 0.022057001 1082.069196 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2008,0,00 1 1 2017 1 5 7 25 25025 250250 1 91 NULL 0 0 2 2008 0 0 0.000306323 1 0.022057001 0.013887794 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2008,0,00 1 1 2017 1 5 7 25 25025 250250 1 90 NULL 0 0 2 2008 0 0 23.8064003 1 0.022057001 1079.312677 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2008,0,00 1 1 2017 1 5 7 25 25025 250250 1 87 NULL 0 0 2 2008 0 0 0.0022569 1 0.022057001 0.102321259 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2008,0,00 1 1 2017 1 5 7 25 25025 250250 1 79 NULL 0 0 2 2008 0 0 0.00172836 1 0.022057001 0.078358794 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2008,0,00 1 1 2017 1 5 7 25 25025 250250 1 66 NULL 0 0 2 2008 0 0 3.65459E-07 1 0.022057001 1.65688E-05 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2008,0,00 1 1 2017 1 5 7 25 25025 250250 1 59 NULL 0 0 2 2008 0 0 2.9351E-06 1 0.022057001 0.000133069 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2008,0,00 1 1 2017 1 5 7 25 25025 250250 1 58 NULL 0 0 2 2008 0 0 4.82553E-07 1 0.022057001 2.18775E-05 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2008,0,00 1 1 2017 1 5 7 25 25025 250250 1 57 NULL 0 0 2 2008 0 0 4.01218E-07 1 0.022057001 1.81901E-05 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2008,0,00 1 1 2017 1 5 7 25 25025 250250 1 56 NULL 0 0 2 2008 0 0 7.5078E-08 1 0.022057001 3.40382E-06 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2008,0,00 1 1 2017 1 5 7 25 25025 250250 1 55 NULL 0 0 2 2008 0 0 2.15079E-06 1 0.022057001 9.75105E-05 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2008,0,00 1 1 2017 1 5 7 25 25025 250250 1 54 NULL 0 0 2 2008 0 0 6.28378E-07 1 0.022057001 2.84888E-05 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2008,0,00 1 1 2017 1 5 7 25 25025 250250 1 53 NULL 0 0 2 2008 0 0 2.1609E-07 1 0.022057001 9.79689E-06 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2008,0,00 1 1 2017 1 5 7 25 25025 250250 1 52 NULL 0 0 2 2008 0 0 4.5172E-06 1 0.022057001 0.000204797 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2008,0,00 1 1 2017 1 5 7 25 25025 250250 1 51 NULL 0 0 2 2008 0 0 1.80637E-07 1 0.022057001 8.18955E-06 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2008,0,00 1 1 2017 1 5 7 25 25025 250250 1 36 NULL 0 0 2 2008 0 0 0 1 0.022057001 0 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2008,0,00 1 1 2017 1 5 7 25 25025 250250 1 35 NULL 0 0 2 2008 0 0 0 1 0.022057001 0 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2008,0,00 1 1 2017 1 5 7 25 25025 250250 1 31 NULL 0 0 2 2008 0 0 0.000198477 1 0.022057001 0.008998368 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2008,0,00 1 1 2017 1 5 7 25 25025 250250 1 5 NULL 0 0 2 2008 0 0 0.00243236 1 0.022057001 0.110276104 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2008,0,00 1 1 2017 1 5 7 25 25025 250250 1 3 NULL 0 0 2 2008 0 0 0.102448002 1 0.022057001 4.644693248 g mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2008,0,00 1 1 2017 1 5 7 25 25025 250250 1 2 NULL 0 0 2 2008 0 0 0.0128808 1 0.022057001 0.583977874 g mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2008,0,00 1 1 2017 1 5 7 25 25025 250250 1 1 NULL 0 0 2 2008 0 0 0.00416073 1 0.022057001 0.188635357 g mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2007,0,00 1 1 2017 1 5 7 25 25025 250250 1 122 NULL 0 0 2 2007 0 0 9.04689E-05 1 0.088779598 0.001019028 g mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2007,0,00 1 1 2017 1 5 7 25 25025 250250 1 121 NULL 0 0 2 2007 0 0 1.58083E-05 1 0.088779598 0.000178062 g mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2007,0,00 1 1 2017 1 5 7 25 25025 250250 1 119 NULL 0 0 2 2007 0 0 0 1 0.088779598 0 g mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2007,0,00 1 1 2017 1 5 7 25 25025 250250 1 118 NULL 0 0 2 2007 0 0 0.00264864 1 0.088779598 0.029833881 g mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2007,0,00 1 1 2017 1 5 7 25 25025 250250 1 117 NULL 0 0 2 2007 0 0 0.000341357 1 0.088779598 0.003844994 g mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2007,0,00 1 1 2017 1 5 7 25 25025 250250 1 116 NULL 0 0 2 2007 0 0 0.00276099 1 0.088779598 0.031099375 g mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2007,0,00 1 1 2017 1 5 7 25 25025 250250 1 115 NULL 0 0 2 2007 0 0 0.00203876 1 0.088779598 0.022964286 g mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2007,0,00 1 1 2017 1 5 7 25 25025 250250 1 112 NULL 0 0 2 2007 0 0 0.000260172 1 0.088779598 0.002930538 g mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2007,0,00 1 1 2017 1 5 7 25 25025 250250 1 111 NULL 0 0 2 2007 0 0 0.000452345 1 0.088779598 0.005095146 g mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2007,0,00 1 1 2017 1 5 7 25 25025 250250 1 110 NULL 0 0 2 2007 0 0 0.00290881 1 0.088779598 0.032764397 g mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2007,0,00 1 1 2017 1 5 7 25 25025 250250 1 107 NULL 0 0 2 2007 0 0 0.00227572 1 0.088779598 0.025633367 g mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2007,0,00 1 1 2017 1 5 7 25 25025 250250 1 106 NULL 0 0 2 2007 0 0 0.0220879 1 0.088779598 0.248794772 g mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2007,0,00 1 1 2017 1 5 7 25 25025 250250 1 100 NULL 0 0 2 2007 0 0 0.00316176 1 0.088779598 0.035613588 g mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2007,0,00 1 1 2017 1 5 7 25 25025 250250 1 98 NULL 0 0 2 2007 0 0 96.09629822 1 0.088779598 1082.414202 g mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2007,0,00 1 1 2017 1 5 7 25 25025 250250 1 91 NULL 0 0 2 2007 0 0 0.001232949 1 0.088779598 0.01388775 g mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2007,0,00 1 1 2017 1 5 7 25 25025 250250 1 90 NULL 0 0 2 2007 0 0 95.82050323 1 0.088779598 1079.307689 g mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2007,0,00 1 1 2017 1 5 7 25 25025 250250 1 87 NULL 0 0 2 2007 0 0 0.0102355 1 0.088779598 0.115291123 g mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2007,0,00 1 1 2017 1 5 7 25 25025 250250 1 79 NULL 0 0 2 2007 0 0 0.00783849 1 0.088779598 0.088291573 g mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2007,0,00 1 1 2017 1 5 7 25 25025 250250 1 66 NULL 0 0 2 2007 0 0 1.47097E-06 1 0.088779598 1.65688E-05 g mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2007,0,00 1 1 2017 1 5 7 25 25025 250250 1 59 NULL 0 0 2 2007 0 0 1.29821E-05 1 0.088779598 0.000146228 g mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2007,0,00 1 1 2017 1 5 7 25 25025 250250 1 58 NULL 0 0 2 2007 0 0 2.13436E-06 1 0.088779598 2.40411E-05 g mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2007,0,00 1 1 2017 1 5 7 25 25025 250250 1 57 NULL 0 0 2 2007 0 0 1.77461E-06 1 0.088779598 1.99889E-05 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2007,0,00 1 1 2017 1 5 7 25 25025 250250 1 56 NULL 0 0 2 2007 0 0 3.32074E-07 1 0.088779598 3.74043E-06 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2007,0,00 1 1 2017 1 5 7 25 25025 250250 1 55 NULL 0 0 2 2007 0 0 9.51307E-06 1 0.088779598 0.000107154 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2007,0,00 1 1 2017 1 5 7 25 25025 250250 1 54 NULL 0 0 2 2007 0 0 2.77935E-06 1 0.088779598 3.13062E-05 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2007,0,00 1 1 2017 1 5 7 25 25025 250250 1 53 NULL 0 0 2 2007 0 0 9.55778E-07 1 0.088779598 1.07657E-05 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2007,0,00 1 1 2017 1 5 7 25 25025 250250 1 52 NULL 0 0 2 2007 0 0 1.99798E-05 1 0.088779598 0.000225049 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2007,0,00 1 1 2017 1 5 7 25 25025 250250 1 51 NULL 0 0 2 2007 0 0 7.98965E-07 1 0.088779598 8.99942E-06 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2007,0,00 1 1 2017 1 5 7 25 25025 250250 1 36 NULL 0 0 2 2007 0 0 0 1 0.088779598 0 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2007,0,00 1 1 2017 1 5 7 25 25025 250250 1 35 NULL 0 0 2 2007 0 0 0 1 0.088779598 0 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2007,0,00 1 1 2017 1 5 7 25 25025 250250 1 31 NULL 0 0 2 2007 0 0 0.000798867 1 0.088779598 0.008998318 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2007,0,00 1 1 2017 1 5 7 25 25025 250250 1 5 NULL 0 0 2 2007 0 0 0.0110312 1 0.088779598 0.124253774 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2007,0,00 1 1 2017 1 5 7 25 25025 250250 1 3 NULL 0 0 2 2007 0 0 0.412349999 1 0.088779598 4.644648163 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2007,0,00 1 1 2017 1 5 7 25 25025 250250 1 2 NULL 0 0 2 2007 0 0 0.058416799 1 0.088779598 0.657998005 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2007,0,00 1 1 2017 1 5 7 25 25025 250250 1 1 NULL 0 0 2 2007 0 0 0.0188697 1 0.088779598 0.212545452 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2006,0,00 1 1 2017 1 5 7 25 25025 250250 1 122 NULL 0 0 2 2006 0 0 0.000533036 1 0.0195402 0.027278944 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2006,0,00 1 1 2017 1 5 7 25 25025 250250 1 121 NULL 0 0 2 2006 0 0 0.000199804 1 0.0195402 0.010225279 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2006,0,00 1 1 2017 1 5 7 25 25025 250250 1 119 NULL 0 0 2 2006 0 0 0 1 0.0195402 0 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2006,0,00 1 1 2017 1 5 7 25 25025 250250 1 118 NULL 0 0 2 2006 0 0 0.00373907 1 0.0195402 0.191352694 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2006,0,00 1 1 2017 1 5 7 25 25025 250250 1 117 NULL 0 0 2 2006 0 0 7.51318E-05 1 0.0195402 0.003844986 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2006,0,00 1 1 2017 1 5 7 25 25025 250250 1 116 NULL 0 0 2 2006 0 0 0.000607687 1 0.0195402 0.031099323 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2006,0,00 1 1 2017 1 5 7 25 25025 250250 1 115 NULL 0 0 2 2006 0 0 6.71011E-05 1 0.0195402 0.003434003 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2006,0,00 1 1 2017 1 5 7 25 25025 250250 1 112 NULL 0 0 2 2006 0 0 0.00307766 1 0.0195402 0.157504017 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2006,0,00 1 1 2017 1 5 7 25 25025 250250 1 111 NULL 0 0 2 2006 0 0 0.00266518 1 0.0195402 0.136394715 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2006,0,00 1 1 2017 1 5 7 25 25025 250250 1 110 NULL 0 0 2 2006 0 0 0.00681673 1 0.0195402 0.348856711 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2006,0,00 1 1 2017 1 5 7 25 25025 250250 1 107 NULL 0 0 2 2006 0 0 0.000500881 1 0.0195402 0.025633361 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2006,0,00 1 1 2017 1 5 7 25 25025 250250 1 106 NULL 0 0 2 2006 0 0 0.0048615 1 0.0195402 0.248794798 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2006,0,00 1 1 2017 1 5 7 25 25025 250250 1 100 NULL 0 0 2 2006 0 0 0.00740951 1 0.0195402 0.379193161 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2006,0,00 1 1 2017 1 5 7 25 25025 250250 1 98 NULL 0 0 2 2006 0 0 21.09140015 1 0.0195402 1079.38507 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2006,0,00 1 1 2017 1 5 7 25 25025 250250 1 91 NULL 0 0 2 2006 0 0 0.000271369 1 0.0195402 0.013887754 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2006,0,00 1 1 2017 1 5 7 25 25025 250250 1 90 NULL 0 0 2 2006 0 0 21.08989906 1 0.0195402 1079.308249 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2006,0,00 1 1 2017 1 5 7 25 25025 250250 1 87 NULL 0 0 2 2006 0 0 0.023287391 1 0.0195402 1.191768318 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2006,0,00 1 1 2017 1 5 7 25 25025 250250 1 79 NULL 0 0 2 2006 0 0 0.0199738 1 0.0195402 1.02219013 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2006,0,00 1 1 2017 1 5 7 25 25025 250250 1 66 NULL 0 0 2 2006 0 0 4.70917E-06 1 0.0195402 0.000240999 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2006,0,00 1 1 2017 1 5 7 25 25025 250250 1 59 NULL 0 0 2 2006 0 0 2.34352E-05 1 0.0195402 0.001199333 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2006,0,00 1 1 2017 1 5 7 25 25025 250250 1 58 NULL 0 0 2 2006 0 0 1.07546E-05 1 0.0195402 0.000550383 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2006,0,00 1 1 2017 1 5 7 25 25025 250250 1 57 NULL 0 0 2 2006 0 0 4.01572E-05 1 0.0195402 0.002055107 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2006,0,00 1 1 2017 1 5 7 25 25025 250250 1 56 NULL 0 0 2 2006 0 0 1.59187E-06 1 0.0195402 8.14664E-05 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2006,0,00 1 1 2017 1 5 7 25 25025 250250 1 55 NULL 0 0 2 2006 0 0 6.37322E-05 1 0.0195402 0.003261594 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2006,0,00 1 1 2017 1 5 7 25 25025 250250 1 54 NULL 0 0 2 2006 0 0 2.10034E-06 1 0.0195402 0.000107488 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2006,0,00 1 1 2017 1 5 7 25 25025 250250 1 53 NULL 0 0 2 2006 0 0 3.5754E-06 1 0.0195402 0.000182977 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2006,0,00 1 1 2017 1 5 7 25 25025 250250 1 52 NULL 0 0 2 2006 0 0 6.35783E-06 1 0.0195402 0.000325372 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2006,0,00 1 1 2017 1 5 7 25 25025 250250 1 51 NULL 0 0 2 2006 0 0 2.34797E-05 1 0.0195402 0.00120161 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2006,0,00 1 1 2017 1 5 7 25 25025 250250 1 36 NULL 0 0 2 2006 0 0 6.5687E-05 1 0.0195402 0.003361634 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2006,0,00 1 1 2017 1 5 7 25 25025 250250 1 35 NULL 0 0 2 2006 0 0 3.30783E-05 1 0.0195402 0.001692833 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2006,0,00 1 1 2017 1 5 7 25 25025 250250 1 31 NULL 0 0 2 2006 0 0 0.00018923 1 0.0195402 0.009684139 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2006,0,00 1 1 2017 1 5 7 25 25025 250250 1 5 NULL 0 0 2 2006 0 0 6.24466E-05 1 0.0195402 0.0031958 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2006,0,00 1 1 2017 1 5 7 25 25025 250250 1 3 NULL 0 0 2 2006 0 0 0.18269451 1 0.0195402 9.349674493 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2006,0,00 1 1 2017 1 5 7 25 25025 250250 1 2 NULL 0 0 2 2006 0 0 0.062876098 1 0.0195402 3.217781692 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2006,0,00 1 1 2017 1 5 7 25 25025 250250 1 1 NULL 0 0 2 2006 0 0 0.0200339 1 0.0195402 1.025265846 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2005,0,00 1 1 2017 1 5 7 25 25025 250250 1 122 NULL 0 0 2 2005 0 0 0.00246265 1 0.090276703 0.027278909 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2005,0,00 1 1 2017 1 5 7 25 25025 250250 1 121 NULL 0 0 2 2005 0 0 0.000923104 1 0.090276703 0.010225274 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2005,0,00	1	1	2017	1	5	7	25	25025	250250	1	119	NULL	0	0	2	2005	0	0	0	1	0.090276703	0	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2005,0,00	1	1	2017	1	5	7	25	25025	250250	1	118	NULL	0	0	2	2005	0	0	0.0172747	1	0.090276703	0.191352802	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2005,0,00	1	1	2017	1	5	7	25	25025	250250	1	117	NULL	0	0	2	2005	0	0	0.000347115	1	0.090276703	0.003845012	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2005,0,00	1	1	2017	1	5	7	25	25025	250250	1	116	NULL	0	0	2	2005	0	0	0.00280756	1	0.090276703	0.031099495	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2005,0,00	1	1	2017	1	5	7	25	25025	250250	1	115	NULL	0	0	2	2005	0	0	0.00031001	1	0.090276703	0.003433998	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2005,0,00	1	1	2017	1	5	7	25	25025	250250	1	112	NULL	0	0	2	2005	0	0	0.014219	1	0.090276703	0.157504644	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2005,0,00	1	1	2017	1	5	7	25	25025	250250	1	111	NULL	0	0	2	2005	0	0	0.0123133	1	0.090276703	0.136395098	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2005,0,00	1	1	2017	1	5	7	25	25025	250250	1	110	NULL	0	0	2	2005	0	0	0.031493701	1	0.090276703	0.348857456	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2005,0,00	1	1	2017	1	5	7	25	25025	250250	1	107	NULL	0	0	2	2005	0	0	0.00231411	1	0.090276703	0.025633524	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2005,0,00	1	1	2017	1	5	7	25	25025	250250	1	106	NULL	0	0	2	2005	0	0	0.0224605	1	0.090276703	0.24879619	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2005,0,00	1	1	2017	1	5	7	25	25025	250250	1	100	NULL	0	0	2	2005	0	0	0.0342324	1	0.090276703	0.379194179	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2005,0,00	1	1	2017	1	5	7	25	25025	250250	1	98	NULL	0	0	2	2005	0	0	97.44380188	1	0.090276703	1079.390345	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2005,0,00	1	1	2017	1	5	7	25	25025	250250	1	91	NULL	0	0	2	2005	0	0	0.001253744	1	0.090276703	0.013887791	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2005,0,00	1	1	2017	1	5	7	25	25025	250250	1	90	NULL	0	0	2	2005	0	0	97.4367981	1	0.090276703	1079.312764	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2005,0,00	1	1	2017	1	5	7	25	25025	250250	1	87	NULL	0	0	2	2005	0	0	0.107588761	1	0.090276703	1.19176661	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2005,0,00	1	1	2017	1	5	7	25	25025	250250	1	79	NULL	0	0	2	2005	0	0	0.092279799	1	0.090276703	1.022188405	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2005,0,00	1	1	2017	1	5	7	25	25025	250250	1	66	NULL	0	0	2	2005	0	0	2.17568E-05	1	0.090276703	0.000241001	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2005,0,00	1	1	2017	1	5	7	25	25025	250250	1	59	NULL	0	0	2	2005	0	0	0.000108272	1	0.090276703	0.001199335	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2005,0,00	1	1	2017	1	5	7	25	25025	250250	1	58	NULL	0	0	2	2005	0	0	4.96868E-05	1	0.090276703	0.000550383	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2005,0,00	1	1	2017	1	5	7	25	25025	250250	1	57	NULL	0	0	2	2005	0	0	0.000185528	1	0.090276703	0.002055104	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2005,0,00	1	1	2017	1	5	7	25	25025	250250	1	56	NULL	0	0	2	2005	0	0	7.35453E-06	1	0.090276703	8.14665E-05	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2005,0,00	1	1	2017	1	5	7	25	25025	250250	1	55	NULL	0	0	2	2005	0	0	0.000294445	1	0.090276703	0.003261583	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2005,0,00	1	1	2017	1	5	7	25	25025	250250	1	54	NULL	0	0	2	2005	0	0	9.70367E-06	1	0.090276703	0.000107488	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2005,0,00	1	1	2017	1	5	7	25	25025	250250	1	53	NULL	0	0	2	2005	0	0	1.65185E-05	1	0.090276703	0.000182976	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2005,0,00	1	1	2017	1	5	7	25	25025	250250	1	52	NULL	0	0	2	2005	0	0	2.93735E-05	1	0.090276703	0.000325372	g	mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2005,0,00 1 1 2017 1 5 7 25 25025 250250 1 51 NULL 0 0 2 2005 0 0 0.000108477 1 0.090276703 0.001201606 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2005,0,00 1 1 2017 1 5 7 25 25025 250250 1 36 NULL 0 0 2 2005 0 0 0.000303477 1 0.090276703 0.003361631 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2005,0,00 1 1 2017 1 5 7 25 25025 250250 1 35 NULL 0 0 2 2005 0 0 0.000152823 1 0.090276703 0.001692829 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2005,0,00 1 1 2017 1 5 7 25 25025 250250 1 31 NULL 0 0 2 2005 0 0 0.000874257 1 0.090276703 0.009684193 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2005,0,00 1 1 2017 1 5 7 25 25025 250250 1 5 NULL 0 0 2 2005 0 0 0.000288506 1 0.090276703 0.003195796 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2005,0,00 1 1 2017 1 5 7 25 25025 250250 1 3 NULL 0 0 2 2005 0 0 0.844065249 1 0.090276703 9.349757121 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2005,0,00 1 1 2017 1 5 7 25 25025 250250 1 2 NULL 0 0 2 2005 0 0 0.290491939 1 0.090276703 3.217795158 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2005,0,00 1 1 2017 1 5 7 25 25025 250250 1 1 NULL 0 0 2 2005 0 0 0.092557997 1 0.090276703 1.025270011 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2004,0,00 1 1 2017 1 5 7 25 25025 250250 1 122 NULL 0 0 2 2004 0 0 0.00498346 1 0.182684004 0.027279127 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2004,0,00 1 1 2017 1 5 7 25 25025 250250 1 121 NULL 0 0 2 2004 0 0 0.00186801 1 0.182684004 0.010225362 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2004,0,00 1 1 2017 1 5 7 25 25025 250250 1 119 NULL 0 0 2 2004 0 0 0 1 0.182684004 0 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2004,0,00 1 1 2017 1 5 7 25 25025 250250 1 118 NULL 0 0 2 2004 0 0 0.034957301 1 0.182684004 0.191353923 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2004,0,00 1 1 2017 1 5 7 25 25025 250250 1 117 NULL 0 0 2 2004 0 0 0.000702425 1 0.182684004 0.003845028 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2004,0,00 1 1 2017 1 5 7 25 25025 250250 1 116 NULL 0 0 2 2004 0 0 0.00568141 1 0.182684004 0.031099658 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2004,0,00 1 1 2017 1 5 7 25 25025 250250 1 115 NULL 0 0 2 2004 0 0 0.000627342 1 0.182684004 0.003434028 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2004,0,00 1 1 2017 1 5 7 25 25025 250250 1 112 NULL 0 0 2 2004 0 0 0.0287739 1 0.182684004 0.157506401 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2004,0,00 1 1 2017 1 5 7 25 25025 250250 1 111 NULL 0 0 2 2004 0 0 0.024917301 1 0.182684004 0.136395635 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2004,0,00 1 1 2017 1 5 7 25 25025 250250 1 110 NULL 0 0 2 2004 0 0 0.063731201 1 0.182684004 0.348860324 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2004,0,00 1 1 2017 1 5 7 25 25025 250250 1 107 NULL 0 0 2 2004 0 0 0.00468285 1 0.182684004 0.025633608 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2004,0,00 1 1 2017 1 5 7 25 25025 250250 1 106 NULL 0 0 2 2004 0 0 0.045451298 1 0.182684004 0.248797362 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2004,0,00 1 1 2017 1 5 7 25 25025 250250 1 100 NULL 0 0 2 2004 0 0 0.069273204 1 0.182684004 0.379196875 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2004,0,00 1 1 2017 1 5 7 25 25025 250250 1 98 NULL 0 0 2 2004 0 0 197.1880035 1 0.182684004 1079.39392 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2004,0,00 1 1 2017 1 5 7 25 25025 250250 1 91 NULL 0 0 2 2004 0 0 0.002537088 1 0.182684004 0.013887851 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2004,0,00 1 1 2017 1 5 7 25 25025 250250 1 90 NULL 0 0 2 2004 0 0 197.173996 1 0.182684004 1079.317244 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2004,0,00 1 1 2017 1 5 7 25 25025 250250 1 87 NULL 0 0 2 2004 0 0 0.217718154 1 0.182684004 1.191774589 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2004,0,00 1 1 2017 1 5 7 25 25025 250250 1 79 NULL 0 0 2 2004 0 0 0.186737999 1 0.182684004 1.022191297 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2004,0,00 1 1 2017 1 5 7 25 25025 250250 1 66 NULL 0 0 2 2004 0 0 4.40271E-05 1 0.182684004 0.000241001 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2004,0,00 1 1 2017 1 5 7 25 25025 250250 1 59 NULL 0 0 2 2004 0 0 0.0002191 1 0.182684004 0.001199339 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2004,0,00 1 1 2017 1 5 7 25 25025 250250 1 58 NULL 0 0 2 2004 0 0 0.000100547 1 0.182684004 0.000550388 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2004,0,00 1 1 2017 1 5 7 25 25025 250250 1 57 NULL 0 0 2 2004 0 0 0.000375438 1 0.182684004 0.002055122 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2004,0,00 1 1 2017 1 5 7 25 25025 250250 1 56 NULL 0 0 2 2004 0 0 1.48827E-05 1 0.182684004 8.14669E-05 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2004,0,00 1 1 2017 1 5 7 25 25025 250250 1 55 NULL 0 0 2 2004 0 0 0.000595845 1 0.182684004 0.003261616 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2004,0,00 1 1 2017 1 5 7 25 25025 250250 1 54 NULL 0 0 2 2004 0 0 1.96365E-05 1 0.182684004 0.000107489 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2004,0,00 1 1 2017 1 5 7 25 25025 250250 1 53 NULL 0 0 2 2004 0 0 3.34271E-05 1 0.182684004 0.000182978 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2004,0,00 1 1 2017 1 5 7 25 25025 250250 1 52 NULL 0 0 2 2004 0 0 5.94406E-05 1 0.182684004 0.000325374 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2004,0,00 1 1 2017 1 5 7 25 25025 250250 1 51 NULL 0 0 2 2004 0 0 0.000219516 1 0.182684004 0.001201616 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2004,0,00 1 1 2017 1 5 7 25 25025 250250 1 36 NULL 0 0 2 2004 0 0 0.000614121 1 0.182684004 0.003361657 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2004,0,00 1 1 2017 1 5 7 25 25025 250250 1 35 NULL 0 0 2 2004 0 0 0.000309256 1 0.182684004 0.001692847 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2004,0,00 1 1 2017 1 5 7 25 25025 250250 1 31 NULL 0 0 2 2004 0 0 0.00176916 1 0.182684004 0.009684264 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2004,0,00 1 1 2017 1 5 7 25 25025 250250 1 5 NULL 0 0 2 2004 0 0 0.000583823 1 0.182684004 0.003195806 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2004,0,00 1 1 2017 1 5 7 25 25025 250250 1 3 NULL 0 0 2 2004 0 0 1.708056331 1 0.182684004 9.349785917 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2004,0,00 1 1 2017 1 5 7 25 25025 250250 1 2 NULL 0 0 2 2004 0 0 0.587842882 1 0.182684004 3.21781255 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2004,0,00 1 1 2017 1 5 7 25 25025 250250 1 1 NULL 0 0 2 2004 0 0 0.187300995 1 0.182684004 1.025273098 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2003,0,00 1 1 2017 1 5 7 25 25025 250250 1 122 NULL 0 0 2 2003 0 0 0.000193071 1 0.00707769 0.027278815 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2003,0,00 1 1 2017 1 5 7 25 25025 250250 1 121 NULL 0 0 2 2003 0 0 7.23712E-05 1 0.00707769 0.010225257 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2003,0,00 1 1 2017 1 5 7 25 25025 250250 1 119 NULL 0 0 2 2003 0 0 0 1 0.00707769 0 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2003,0,00 1 1 2017 1 5 7 25 25025 250250 1 118 NULL 0 0 2 2003 0 0 0.00135433 1 0.00707769 0.191351973 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2003,0,00 1 1 2017 1 5 7 25 25025 250250 1 117 NULL 0 0 2 2003 0 0 2.72137E-05 1 0.00707769 0.003844997 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2003,0,00 1 1 2017 1 5 7 25 25025 250250 1 116 NULL 0 0 2 2003 0 0 0.000220112 1 0.00707769 0.03109941 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2003,0,00 1 1 2017 1 5 7 25 25025 250250 1 115 NULL 0 0 2 2003 0 0 2.43048E-05 1 0.00707769 0.003434002 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2003,0,00 1 1 2017 1 5 7 25 25025 250250 1 112 NULL 0 0 2 2003 0 0 0.00111476 1 0.00707769 0.157503353 g mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2003,0,00 1 1 2017 1 5 7 25 25025 250250 1 111 NULL 0 0 2 2003 0 0 0.000965357 1 0.00707769 0.136394356 g mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2003,0,00 1 1 2017 1 5 7 25 25025 250250 1 110 NULL 0 0 2 2003 0 0 0.0024691 1 0.00707769 0.348856757 g mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2003,0,00 1 1 2017 1 5 7 25 25025 250250 1 107 NULL 0 0 2 2003 0 0 0.000181425 1 0.00707769 0.025633363 g mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2003,0,00 1 1 2017 1 5 7 25 25025 250250 1 106 NULL 0 0 2 2003 0 0 0.00176089 1 0.00707769 0.248794445 g mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2003,0,00 1 1 2017 1 5 7 25 25025 250250 1 100 NULL 0 0 2 2003 0 0 0.00268381 1 0.00707769 0.379192911 g mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2003,0,00 1 1 2017 1 5 7 25 25025 250250 1 98 NULL 0 0 2 2003 0 0 7.639570236 1 0.00707769 1079.387485 g mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2003,0,00 1 1 2017 1 5 7 25 25025 250250 1 91 NULL 0 0 2 2003 0 0 9.82934E-05 1 0.00707769 0.013887775 g mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2003,0,00 1 1 2017 1 5 7 25 25025 250250 1 90 NULL 0 0 2 2003 0 0 7.639019966 1 0.00707769 1079.309737 g mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2003,0,00 1 1 2017 1 5 7 25 25025 250250 1 87 NULL 0 0 2 2003 0 0 0.008434937 1 0.00707769 1.191764132 g mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2003,0,00 1 1 2017 1 5 7 25 25025 250250 1 79 NULL 0 0 2 2003 0 0 0.00723471 1 0.00707769 1.022185146 g mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2003,0,00 1 1 2017 1 5 7 25 25025 250250 1 66 NULL 0 0 2 2003 0 0 1.70572E-06 1 0.00707769 0.000241 g mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2003,0,00 1 1 2017 1 5 7 25 25025 250250 1 59 NULL 0 0 2 2003 0 0 8.48848E-06 1 0.00707769 0.001199329 g mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2003,0,00 1 1 2017 1 5 7 25 25025 250250 1 58 NULL 0 0 2 2003 0 0 3.89544E-06 1 0.00707769 0.000550383 g mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2003,0,00 1 1 2017 1 5 7 25 25025 250250 1 57 NULL 0 0 2 2003 0 0 1.45454E-05 1 0.00707769 0.002055105 g mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2003,0,00 1 1 2017 1 5 7 25 25025 250250 1 56 NULL 0 0 2 2003 0 0 5.76594E-07 1 0.00707769 8.14664E-05 g mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2003,0,00 1 1 2017 1 5 7 25 25025 250250 1 55 NULL 0 0 2 2003 0 0 2.30845E-05 1 0.00707769 0.003261587 g mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2003,0,00 1 1 2017 1 5 7 25 25025 250250 1 54 NULL 0 0 2 2003 0 0 7.60766E-07 1 0.00707769 0.000107488 g mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2003,0,00 1 1 2017 1 5 7 25 25025 250250 1 53 NULL 0 0 2 2003 0 0 1.29505E-06 1 0.00707769 0.000182976 g mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2003,0,00 1 1 2017 1 5 7 25 25025 250250 1 52 NULL 0 0 2 2003 0 0 2.30287E-06 1 0.00707769 0.00032537 g mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2003,0,00 1 1 2017 1 5 7 25 25025 250250 1 51 NULL 0 0 2 2003 0 0 8.50459E-06 1 0.00707769 0.001201605 g mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2003,0,00 1 1 2017 1 5 7 25 25025 250250 1 36 NULL 0 0 2 2003 0 0 2.37925E-05 1 0.00707769 0.003361619 g mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2003,0,00 1 1 2017 1 5 7 25 25025 250250 1 35 NULL 0 0 2 2003 0 0 1.19813E-05 1 0.00707769 0.001692826 g mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2003,0,00 1 1 2017 1 5 7 25 25025 250250 1 31 NULL 0 0 2 2003 0 0 6.85416E-05 1 0.00707769 0.009684177 g mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2003,0,00 1 1 2017 1 5 7 25 25025 250250 1 5 NULL 0 0 2 2003 0 0 2.26188E-05 1 0.00707769 0.003195793 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2003,0,00 1 1 2017 1 5 7 25 25025 250250 1 3 NULL 0 0 2 2003 0 0 0.06617441 1 0.00707769 9.34971838 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2003,0,00 1 1 2017 1 5 7 25 25025 250250 1 2 NULL 0 0 2 2003 0 0 0.022774469 1 0.00707769 3.217782697 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2003,0,00 1 1 2017 1 5 7 25 25025 250250 1 1 NULL 0 0 2 2003 0 0 0.00725652 1 0.00707769 1.025266685 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2002,0,00 1 1 2017 1 5 7 25 25025 250250 1 122 NULL 0 0 2 2002 0 0 0.000450392 1 0.0149212 0.030184702 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2002,0,00 1 1 2017 1 5 7 25 25025 250250 1 121 NULL 0 0 2 2002 0 0 0.000168826 1 0.0149212 0.011314505 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2002,0,00 1 1 2017 1 5 7 25 25025 250250 1 119 NULL 0 0 2 2002 0 0 0 1 0.0149212 0 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2002,0,00 1 1 2017 1 5 7 25 25025 250250 1 118 NULL 0 0 2 2002 0 0 0.00315935 1 0.0149212 0.211735646 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2002,0,00 1 1 2017 1 5 7 25 25025 250250 1 117 NULL 0 0 2 2002 0 0 5.73719E-05 1 0.0149212 0.003844992 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2002,0,00 1 1 2017 1 5 7 25 25025 250250 1 116 NULL 0 0 2 2002 0 0 0.00046404 1 0.0149212 0.031099374 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2002,0,00 1 1 2017 1 5 7 25 25025 250250 1 115 NULL 0 0 2 2002 0 0 5.66975E-05 1 0.0149212 0.003799795 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2002,0,00 1 1 2017 1 5 7 25 25025 250250 1 112 NULL 0 0 2 2002 0 0 0.00260049 1 0.0149212 0.174281561 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2002,0,00 1 1 2017 1 5 7 25 25025 250250 1 111 NULL 0 0 2 2002 0 0 0.00225196 1 0.0149212 0.150923521 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2002,0,00 1 1 2017 1 5 7 25 25025 250250 1 110 NULL 0 0 2 2002 0 0 0.00575984 1 0.0149212 0.386017192 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2002,0,00 1 1 2017 1 5 7 25 25025 250250 1 107 NULL 0 0 2 2002 0 0 0.000382481 1 0.0149212 0.025633393 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2002,0,00 1 1 2017 1 5 7 25 25025 250250 1 106 NULL 0 0 2 2002 0 0 0.00371232 1 0.0149212 0.248794996 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2002,0,00 1 1 2017 1 5 7 25 25025 250250 1 100 NULL 0 0 2 2002 0 0 0.00626071 1 0.0149212 0.419584862 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2002,0,00 1 1 2017 1 5 7 25 25025 250250 1 98 NULL 0 0 2 2002 0 0 16.10569954 1 0.0149212 1079.383631 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2002,0,00 1 1 2017 1 5 7 25 25025 250250 1 91 NULL 0 0 2 2002 0 0 0.000207222 1 0.0149212 0.01388777 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2002,0,00 1 1 2017 1 5 7 25 25025 250250 1 90 NULL 0 0 2 2002 0 0 16.10460091 1 0.0149212 1079.310002 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2002,0,00 1 1 2017 1 5 7 25 25025 250250 1 87 NULL 0 0 2 2002 0 0 0.02507912 1 0.0149212 1.680770928 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2002,0,00 1 1 2017 1 5 7 25 25025 250250 1 79 NULL 0 0 2 2002 0 0 0.021510599 1 0.0149212 1.441613176 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2002,0,00 1 1 2017 1 5 7 25 25025 250250 1 66 NULL 0 0 2 2002 0 0 3.59601E-06 1 0.0149212 0.000241 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2002,0,00 1 1 2017 1 5 7 25 25025 250250 1 59 NULL 0 0 2 2002 0 0 1.98017E-05 1 0.0149212 0.001327085 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2002,0,00 1 1 2017 1 5 7 25 25025 250250 1 58 NULL 0 0 2 2002 0 0 9.08717E-06 1 0.0149212 0.000609011 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2002,0,00 1 1 2017 1 5 7 25 25025 250250 1 57 NULL 0 0 2 2002 0 0 3.39311E-05 1 0.0149212 0.00227402 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2002,0,00 1 1 2017 1 5 7 25 25025 250250 1 56 NULL 0 0 2 2002 0 0 1.34506E-06 1 0.0149212 9.01442E-05 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2002,0,00 1 1 2017 1 5 7 25 25025 250250 1 55 NULL 0 0 2 2002 0 0 5.38509E-05 1 0.0149212 0.003609019 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2002,0,00 1 1 2017 1 5 7 25 25025 250250 1 54 NULL 0 0 2 2002 0 0 1.77469E-06 1 0.0149212 0.000118937 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2002,0,00 1 1 2017 1 5 7 25 25025 250250 1 53 NULL 0 0 2 2002 0 0 3.02106E-06 1 0.0149212 0.000202468 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2002,0,00 1 1 2017 1 5 7 25 25025 250250 1 52 NULL 0 0 2 2002 0 0 5.37209E-06 1 0.0149212 0.000360031 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2002,0,00 1 1 2017 1 5 7 25 25025 250250 1 51 NULL 0 0 2 2002 0 0 1.98393E-05 1 0.0149212 0.001329605 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2002,0,00 1 1 2017 1 5 7 25 25025 250250 1 36 NULL 0 0 2 2002 0 0 5.55026E-05 1 0.0149212 0.003719714 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2002,0,00 1 1 2017 1 5 7 25 25025 250250 1 35 NULL 0 0 2 2002 0 0 2.79497E-05 1 0.0149212 0.001873154 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2002,0,00 1 1 2017 1 5 7 25 25025 250250 1 31 NULL 0 0 2 2002 0 0 0.0001445 1 0.0149212 0.009684207 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2002,0,00 1 1 2017 1 5 7 25 25025 250250 1 5 NULL 0 0 2 2002 0 0 4.62744E-05 1 0.0149212 0.003101249 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2002,0,00 1 1 2017 1 5 7 25 25025 250250 1 3 NULL 0 0 2 2002 0 0 0.242621377 1 0.0149212 16.26017811 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2002,0,00 1 1 2017 1 5 7 25 25025 250250 1 2 NULL 0 0 2 2002 0 0 0.115804128 1 0.0149212 7.761046348 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2002,0,00 1 1 2017 1 5 7 25 25025 250250 1 1 NULL 0 0 2 2002 0 0 0.0215551 1 0.0149212 1.44459554 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2001,0,00 1 1 2017 1 5 7 25 25025 250250 1 122 NULL 0 0 2 2001 0 0 0.000527649 1 0.017480699 0.030184663 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2001,0,00 1 1 2017 1 5 7 25 25025 250250 1 121 NULL 0 0 2 2001 0 0 0.000197785 1 0.017480699 0.011314479 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2001,0,00 1 1 2017 1 5 7 25 25025 250250 1 119 NULL 0 0 2 2001 0 0 0 1 0.017480699 0 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2001,0,00 1 1 2017 1 5 7 25 25025 250250 1 118 NULL 0 0 2 2001 0 0 0.00370128 1 0.017480699 0.211735242 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2001,0,00 1 1 2017 1 5 7 25 25025 250250 1 117 NULL 0 0 2 2001 0 0 6.72132E-05 1 0.017480699 0.003844995 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2001,0,00 1 1 2017 1 5 7 25 25025 250250 1 116 NULL 0 0 2 2001 0 0 0.00054364 1 0.017480699 0.031099442 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2001,0,00 1 1 2017 1 5 7 25 25025 250250 1 115 NULL 0 0 2 2001 0 0 6.6423E-05 1 0.017480699 0.003799791 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2001,0,00 1 1 2017 1 5 7 25 25025 250250 1 112 NULL 0 0 2 2001 0 0 0.00304656 1 0.017480699 0.174281363 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2001,0,00 1 1 2017 1 5 7 25 25025 250250 1 111 NULL 0 0 2 2001 0 0 0.00263825 1 0.017480699 0.150923589 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2001,0,00 1 1 2017 1 5 7 25 25025 250250 1 110 NULL 0 0 2 2001 0 0 0.00674785 1 0.017480699 0.386017177 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2001,0,00 1 1 2017 1 5 7 25 25025 250250 1 107 NULL 0 0 2 2001 0 0 0.00044809 1 0.017480699 0.025633414 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2001,0,00 1 1 2017 1 5 7 25 25025 250250 1 106 NULL 0 0 2 2001 0 0 0.00434912 1 0.017480699 0.248795536 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2001,0,00 1 1 2017 1 5 7 25 25025 250250 1 100 NULL 0 0 2 2001 0 0 0.00733464 1 0.017480699 0.419585031 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2001,0,00 1 1 2017 1 5 7 25 25025 250250 1 98 NULL 0 0 2 2001 0 0 18.86840057 1 0.017480699 1079.384766 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2001,0,00 1 1 2017 1 5 7 25 25025 250250 1 91 NULL 0 0 2 2001 0 0 0.000242768 1 0.017480699 0.013887784 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2001,0,00 1 1 2017 1 5 7 25 25025 250250 1 90 NULL 0 0 2 2001 0 0 18.86709976 1 0.017480699 1079.310352 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2001,0,00 1 1 2017 1 5 7 25 25025 250250 1 87 NULL 0 0 2 2001 0 0 0.029381009 1 0.017480699 1.6807685 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2001,0,00 1 1 2017 1 5 7 25 25025 250250 1 79 NULL 0 0 2 2001 0 0 0.0252003 1 0.017480699 1.441607079 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2001,0,00 1 1 2017 1 5 7 25 25025 250250 1 66 NULL 0 0 2 2001 0 0 4.21285E-06 1 0.017480699 0.000241 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2001,0,00 1 1 2017 1 5 7 25 25025 250250 1 59 NULL 0 0 2 2001 0 0 2.31984E-05 1 0.017480699 0.001327086 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2001,0,00 1 1 2017 1 5 7 25 25025 250250 1 58 NULL 0 0 2 2001 0 0 1.06459E-05 1 0.017480699 0.000609009 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2001,0,00 1 1 2017 1 5 7 25 25025 250250 1 57 NULL 0 0 2 2001 0 0 3.97514E-05 1 0.017480699 0.002274017 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2001,0,00 1 1 2017 1 5 7 25 25025 250250 1 56 NULL 0 0 2 2001 0 0 1.57579E-06 1 0.017480699 9.01446E-05 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2001,0,00 1 1 2017 1 5 7 25 25025 250250 1 55 NULL 0 0 2 2001 0 0 6.30881E-05 1 0.017480699 0.003609014 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2001,0,00 1 1 2017 1 5 7 25 25025 250250 1 54 NULL 0 0 2 2001 0 0 2.07911E-06 1 0.017480699 0.000118937 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2001,0,00 1 1 2017 1 5 7 25 25025 250250 1 53 NULL 0 0 2 2001 0 0 3.53927E-06 1 0.017480699 0.000202467 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2001,0,00 1 1 2017 1 5 7 25 25025 250250 1 52 NULL 0 0 2 2001 0 0 6.29358E-06 1 0.017480699 0.00036003 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2001,0,00 1 1 2017 1 5 7 25 25025 250250 1 51 NULL 0 0 2 2001 0 0 2.32424E-05 1 0.017480699 0.001329604 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2001,0,00 1 1 2017 1 5 7 25 25025 250250 1 36 NULL 0 0 2 2001 0 0 6.50232E-05 1 0.017480699 0.003719714 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2001,0,00 1 1 2017 1 5 7 25 25025 250250 1 35 NULL 0 0 2 2001 0 0 3.2744E-05 1 0.017480699 0.001873152 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2001,0,00 1 1 2017 1 5 7 25 25025 250250 1 31 NULL 0 0 2 2001 0 0 0.000169286 1 0.017480699 0.009684166 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2001,0,00 1 1 2017 1 5 7 25 25025 250250 1 5 NULL 0 0 2 2001 0 0 5.4212E-05 1 0.017480699 0.003101247 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2001,0,00 1 1 2017 1 5 7 25 25025 250250 1 3 NULL 0 0 2 2001 0 0 0.284240961 1 0.017480699 16.260274 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2001,0,00 1 1 2017 1 5 7 25 25025 250250 1 2 NULL 0 0 2 2001 0 0 0.135669068 1 0.017480699 7.761077793 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2001,0,00 1 1 2017 1 5 7 25 25025 250250 1 1 NULL 0 0 2 2001 0 0 0.025252599 1 0.017480699 1.444598913 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2000,0,00 1 1 2017 1 5 7 25 25025 250250 1 122 NULL 0 0 2 2000 0 0 0.000385234 1 0.0127626 0.030184602 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2000,0,00 1 1 2017 1 5 7 25 25025 250250 1 121 NULL 0 0 2 2000 0 0 0.000144402 1 0.0127626 0.011314466 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2000,0,00 1 1 2017 1 5 7 25 25025 250250 1 119 NULL 0 0 2 2000 0 0 0 1 0.0127626 0 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2000,0,00 1 1 2017 1 5 7 25 25025 250250 1 118 NULL 0 0 2 2000 0 0 0.00270229 1 0.0127626 0.211735073 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2000,0,00 1 1 2017 1 5 7 25 25025 250250 1 117 NULL 0 0 2 2000 0 0 4.90722E-05 1 0.0127626 0.003845 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2000,0,00 1 1 2017 1 5 7 25 25025 250250 1 116 NULL 0 0 2 2000 0 0 0.00039691 1 0.0127626 0.031099464 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2000,0,00 1 1 2017 1 5 7 25 25025 250250 1 115 NULL 0 0 2 2000 0 0 4.84952E-05 1 0.0127626 0.00379979 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2000,0,00 1 1 2017 1 5 7 25 25025 250250 1 112 NULL 0 0 2 2000 0 0 0.00222429 1 0.0127626 0.174281895 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2000,0,00 1 1 2017 1 5 7 25 25025 250250 1 111 NULL 0 0 2 2000 0 0 0.00192617 1 0.0127626 0.150923011 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2000,0,00 1 1 2017 1 5 7 25 25025 250250 1 110 NULL 0 0 2 2000 0 0 0.00492658 1 0.0127626 0.386016967 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2000,0,00 1 1 2017 1 5 7 25 25025 250250 1 107 NULL 0 0 2 2000 0 0 0.000327149 1 0.0127626 0.025633414 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2000,0,00 1 1 2017 1 5 7 25 25025 250250 1 106 NULL 0 0 2 2000 0 0 0.00317528 1 0.0127626 0.248795712 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2000,0,00 1 1 2017 1 5 7 25 25025 250250 1 100 NULL 0 0 2 2000 0 0 0.00535499 1 0.0127626 0.419584563 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2000,0,00 1 1 2017 1 5 7 25 25025 250250 1 98 NULL 0 0 2 2000 0 0 13.77569962 1 0.0127626 1079.380379 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2000,0,00 1 1 2017 1 5 7 25 25025 250250 1 91 NULL 0 0 2 2000 0 0 0.000177244 1 0.0127626 0.013887742 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2000,0,00 1 1 2017 1 5 7 25 25025 250250 1 90 NULL 0 0 2 2000 0 0 13.7748003 1 0.0127626 1079.309914 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2000,0,00 1 1 2017 1 5 7 25 25025 250250 1 87 NULL 0 0 2 2000 0 0 0.021451069 1 0.0127626 1.680775835 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2000,0,00 1 1 2017 1 5 7 25 25025 250250 1 79 NULL 0 0 2 2000 0 0 0.0183987 1 0.0127626 1.441610708 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2000,0,00 1 1 2017 1 5 7 25 25025 250250 1 66 NULL 0 0 2 2000 0 0 3.07578E-06 1 0.0127626 0.000240999 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2000,0,00 1 1 2017 1 5 7 25 25025 250250 1 59 NULL 0 0 2 2000 0 0 1.6937E-05 1 0.0127626 0.001327081 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2000,0,00 1 1 2017 1 5 7 25 25025 250250 1 58 NULL 0 0 2 2000 0 0 7.77255E-06 1 0.0127626 0.00060901 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2000,0,00 1 1 2017 1 5 7 25 25025 250250 1 57 NULL 0 0 2 2000 0 0 2.90223E-05 1 0.0127626 0.002274012 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2000,0,00 1 1 2017 1 5 7 25 25025 250250 1 56 NULL 0 0 2 2000 0 0 1.15047E-06 1 0.0127626 9.01439E-05 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2000,0,00 1 1 2017 1 5 7 25 25025 250250 1 55 NULL 0 0 2 2000 0 0 4.60603E-05 1 0.0127626 0.003609006 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2000,0,00 1 1 2017 1 5 7 25 25025 250250 1 54 NULL 0 0 2 2000 0 0 1.51795E-06 1 0.0127626 0.000118937 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2000,0,00 1 1 2017 1 5 7 25 25025 250250 1 53 NULL 0 0 2 2000 0 0 2.58401E-06 1 0.0127626 0.000202467 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2000,0,00 1 1 2017 1 5 7 25 25025 250250 1 52 NULL 0 0 2 2000 0 0 4.59491E-06 1 0.0127626 0.000360029 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2000,0,00 1 1 2017 1 5 7 25 25025 250250 1 51 NULL 0 0 2 2000 0
0 1.69692E-05 1 0.0127626 0.001329604 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2000,0,00 1 1 2017 1 5 7 25 25025 250250 1 36 NULL 0 0 2 2000 0
0 4.74732E-05 1 0.0127626 0.003719712 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2000,0,00 1 1 2017 1 5 7 25 25025 250250 1 35 NULL 0 0 2 2000 0
0 2.39063E-05 1 0.0127626 0.001873153 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2000,0,00 1 1 2017 1 5 7 25 25025 250250 1 31 NULL 0 0 2 2000 0
0 0.000123595 1 0.0127626 0.009684156 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2000,0,00 1 1 2017 1 5 7 25 25025 250250 1 5 NULL 0 0 2 2000 0
0 3.95799E-05 1 0.0127626 0.003101242 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2000,0,00 1 1 2017 1 5 7 25 25025 250250 1 3 NULL 0 0 2 2000 0
0 0.207523316 1 0.0127626 16.26027003 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2000,0,00 1 1 2017 1 5 7 25 25025 250250 1 2 NULL 0 0 2 2000 0
0 0.09905114 1 0.0127626 7.76104737 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,2000,0,00 1 1 2017 1 5 7 25 25025 250250 1 1 NULL 0 0 2 2000 0
0 0.018436899 1 0.0127626 1.44460376 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1999,0,00 1 1 2017 1 5 7 25 25025 250250 1 122 NULL 0 0 2 1999 0
0 0.000157297 1 0.0052112 0.030184411 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1999,0,00 1 1 2017 1 5 7 25 25025 250250 1 121 NULL 0 0 2 1999 0
0 5.89616E-05 1 0.0052112 0.011314399 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1999,0,00 1 1 2017 1 5 7 25 25025 250250 1 119 NULL 0 0 2 1999 0
0 0 1 0.0052112 0 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1999,0,00 1 1 2017 1 5 7 25 25025 250250 1 118 NULL 0 0 2 1999 0
0 0.00110339 1 0.0052112 0.211734339 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1999,0,00 1 1 2017 1 5 7 25 25025 250250 1 117 NULL 0 0 2 1999 0
0 2.0037E-05 1 0.0052112 0.003844988 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1999,0,00 1 1 2017 1 5 7 25 25025 250250 1 116 NULL 0 0 2 1999 0
0 0.000162065 1 0.0052112 0.031099362 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1999,0,00 1 1 2017 1 5 7 25 25025 250250 1 115 NULL 0 0 2 1999 0
0 1.98014E-05 1 0.0052112 0.003799777 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1999,0,00 1 1 2017 1 5 7 25 25025 250250 1 112 NULL 0 0 2 1999 0
0 0.000908215 1 0.0052112 0.174281353 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1999,0,00 1 1 2017 1 5 7 25 25025 250250 1 111 NULL 0 0 2 1999 0
0 0.000786487 1 0.0052112 0.150922436 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1999,0,00 1 1 2017 1 5 7 25 25025 250250 1 110 NULL 0 0 2 1999 0
0 0.0020116 1 0.0052112 0.386014721 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1999,0,00 1 1 2017 1 5 7 25 25025 250250 1 107 NULL 0 0 2 1999 0
0 0.000133581 1 0.0052112 0.025633442 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1999,0,00 1 1 2017 1 5 7 25 25025 250250 1 106 NULL 0 0 2 1999 0
0 0.00129652 1 0.0052112 0.248794899 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1999,0,00 1 1 2017 1 5 7 25 25025 250250 1 100 NULL 0 0 2 1999 0
0 0.00218653 1 0.0052112 0.419582821 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1999,0,00 1 1 2017 1 5 7 25 25025 250250 1 98 NULL 0 0 2 1999 0
0 5.624879837 1 0.0052112 1079.382816 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1999,0,00 1 1 2017 1 5 7 25 25025 250250 1 91 NULL 0 0 2 1999 0
0 7.23718E-05 1 0.0052112 0.013887742 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1999,0,00 1 1 2017 1 5 7 25 25025 250250 1 90 NULL 0 0 2 1999 0
0 5.624489784 1 0.0052112 1079.307967 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1999,0,00 1 1 2017 1 5 7 25 25025 250250 1 87 NULL 0 0 2 1999 0
0 0.008758813 1 0.0052112 1.680766997 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1999,0,00 1 1 2017 1 5 7 25 25025 250250 1 79 NULL 0 0 2 1999 0 0 0.0075125 1 0.0052112 1.441606521 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1999,0,00 1 1 2017 1 5 7 25 25025 250250 1 66 NULL 0 0 2 1999 0 0 1.2559E-06 1 0.0052112 0.000241 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1999,0,00 1 1 2017 1 5 7 25 25025 250250 1 59 NULL 0 0 2 1999 0 0 6.91566E-06 1 0.0052112 0.001327076 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1999,0,00 1 1 2017 1 5 7 25 25025 250250 1 58 NULL 0 0 2 1999 0 0 3.17365E-06 1 0.0052112 0.000609006 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1999,0,00 1 1 2017 1 5 7 25 25025 250250 1 57 NULL 0 0 2 1999 0 0 1.18503E-05 1 0.0052112 0.002274006 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1999,0,00 1 1 2017 1 5 7 25 25025 250250 1 56 NULL 0 0 2 1999 0 0 4.69757E-07 1 0.0052112 9.01437E-05 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1999,0,00 1 1 2017 1 5 7 25 25025 250250 1 55 NULL 0 0 2 1999 0 0 1.88072E-05 1 0.0052112 0.003608996 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1999,0,00 1 1 2017 1 5 7 25 25025 250250 1 54 NULL 0 0 2 1999 0 0 6.19804E-07 1 0.0052112 0.000118937 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1999,0,00 1 1 2017 1 5 7 25 25025 250250 1 53 NULL 0 0 2 1999 0 0 1.05509E-06 1 0.0052112 0.000202466 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1999,0,00 1 1 2017 1 5 7 25 25025 250250 1 52 NULL 0 0 2 1999 0 0 1.87618E-06 1 0.0052112 0.000360028 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1999,0,00 1 1 2017 1 5 7 25 25025 250250 1 51 NULL 0 0 2 1999 0 0 6.92878E-06 1 0.0052112 0.001329594 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1999,0,00 1 1 2017 1 5 7 25 25025 250250 1 36 NULL 0 0 2 1999 0 0 1.9384E-05 1 0.0052112 0.003719681 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1999,0,00 1 1 2017 1 5 7 25 25025 250250 1 35 NULL 0 0 2 1999 0 0 9.76132E-06 1 0.0052112 0.001873142 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1999,0,00 1 1 2017 1 5 7 25 25025 250250 1 31 NULL 0 0 2 1999 0 0 5.04661E-05 1 0.0052112 0.009684161 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1999,0,00 1 1 2017 1 5 7 25 25025 250250 1 5 NULL 0 0 2 1999 0 0 1.61612E-05 1 0.0052112 0.003101249 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1999,0,00 1 1 2017 1 5 7 25 25025 250250 1 3 NULL 0 0 2 1999 0 0 0.084735155 1 0.0052112 16.26019986 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1999,0,00 1 1 2017 1 5 7 25 25025 250250 1 2 NULL 0 0 2 1999 0 0 0.04044443 1 0.0052112 7.761058718 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1999,0,00 1 1 2017 1 5 7 25 25025 250250 1 1 NULL 0 0 2 1999 0 0 0.00752808 1 0.0052112 1.444596253 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1998,0,00 1 1 2017 1 5 7 25 25025 250250 1 122 NULL 0 0 2 1998 0 0 6.67761E-05 1 0.00221225 0.030184699 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1998,0,00 1 1 2017 1 5 7 25 25025 250250 1 121 NULL 0 0 2 1998 0 0 2.50304E-05 1 0.00221225 0.011314454 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1998,0,00 1 1 2017 1 5 7 25 25025 250250 1 119 NULL 0 0 2 1998 0 0 0 1 0.00221225 0 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1998,0,00 1 1 2017 1 5 7 25 25025 250250 1 118 NULL 0 0 2 1998 0 0 0.000468412 1 0.00221225 0.211735575 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1998,0,00 1 1 2017 1 5 7 25 25025 250250 1 117 NULL 0 0 2 1998 0 0 8.5061E-06 1 0.00221225 0.003845 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1998,0,00 1 1 2017 1 5 7 25 25025 250250 1 116 NULL 0 0 2 1998 0 0 6.87998E-05 1 0.00221225 0.031099472 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1998,0,00 1 1 2017 1 5 7 25 25025 250250 1 115 NULL 0 0 2 1998 0 0 8.40609E-06 1 0.00221225 0.003799792 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1998,0,00 1 1 2017 1 5 7 25 25025 250250 1 112 NULL 0 0 2 1998 0 0 0.000385554 1 0.00221225 0.174281401 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1998,0,00 1 1 2017 1 5 7 25 25025 250250 1 111 NULL 0 0 2 1998 0 0 0.00033388 1 0.00221225 0.150923269 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1998,0,00 1 1 2017 1 5 7 25 25025 250250 1 110 NULL 0 0 2 1998 0 0 0.000853966 1 0.00221225 0.386016963 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1998,0,00 1 1 2017 1 5 7 25 25025 250250 1 107 NULL 0 0 2 1998 0 0 5.67076E-05 1 0.00221225 0.025633451 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1998,0,00 1 1 2017 1 5 7 25 25025 250250 1 106 NULL 0 0 2 1998 0 0 0.000550398 1 0.00221225 0.24879559 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1998,0,00 1 1 2017 1 5 7 25 25025 250250 1 100 NULL 0 0 2 1998 0 0 0.000928227 1 0.00221225 0.419585044 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1998,0,00 1 1 2017 1 5 7 25 25025 250250 1 98 NULL 0 0 2 1998 0 0 2.387870073 1 0.00221225 1079.38532 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1998,0,00 1 1 2017 1 5 7 25 25025 250250 1 91 NULL 0 0 2 1998 0 0 3.07232E-05 1 0.00221225 0.013887765 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1998,0,00 1 1 2017 1 5 7 25 25025 250250 1 90 NULL 0 0 2 1998 0 0 2.387700081 1 0.00221225 1079.308478 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1998,0,00 1 1 2017 1 5 7 25 25025 250250 1 87 NULL 0 0 2 1998 0 0 0.003718267 1 0.00221225 1.680762626 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1998,0,00 1 1 2017 1 5 7 25 25025 250250 1 79 NULL 0 0 2 1998 0 0 0.00318918 1 0.00221225 1.441600263 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1998,0,00 1 1 2017 1 5 7 25 25025 250250 1 66 NULL 0 0 2 1998 0 0 5.33152E-07 1 0.00221225 0.000241 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1998,0,00 1 1 2017 1 5 7 25 25025 250250 1 59 NULL 0 0 2 1998 0 0 2.93584E-06 1 0.00221225 0.001327083 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1998,0,00 1 1 2017 1 5 7 25 25025 250250 1 58 NULL 0 0 2 1998 0 0 1.34728E-06 1 0.00221225 0.000609009 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1998,0,00 1 1 2017 1 5 7 25 25025 250250 1 57 NULL 0 0 2 1998 0 0 5.0307E-06 1 0.00221225 0.00227402 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1998,0,00 1 1 2017 1 5 7 25 25025 250250 1 56 NULL 0 0 2 1998 0 0 1.99422E-07 1 0.00221225 9.01444E-05 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1998,0,00 1 1 2017 1 5 7 25 25025 250250 1 55 NULL 0 0 2 1998 0 0 7.98404E-06 1 0.00221225 0.003609014 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1998,0,00 1 1 2017 1 5 7 25 25025 250250 1 54 NULL 0 0 2 1998 0 0 2.6312E-07 1 0.00221225 0.000118938 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1998,0,00 1 1 2017 1 5 7 25 25025 250250 1 53 NULL 0 0 2 1998 0 0 4.47908E-07 1 0.00221225 0.000202467 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1998,0,00 1 1 2017 1 5 7 25 25025 250250 1 52 NULL 0 0 2 1998 0 0 7.96477E-07 1 0.00221225 0.00036003 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1998,0,00 1 1 2017 1 5 7 25 25025 250250 1 51 NULL 0 0 2 1998 0 0 2.94141E-06 1 0.00221225 0.001329601 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1998,0,00 1 1 2017 1 5 7 25 25025 250250 1 36 NULL 0 0 2 1998 0 0 8.22894E-06 1 0.00221225 0.003719715 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1998,0,00 1 1 2017 1 5 7 25 25025 250250 1 35 NULL 0 0 2 1998 0 0 4.14389E-06 1 0.00221225 0.001873156 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1998,0,00 1 1 2017 1 5 7 25 25025 250250 1 31 NULL 0 0 2 1998 0 0 2.14238E-05 1 0.00221225 0.009684168 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1998,0,00 1 1 2017 1 5 7 25 25025 250250 1 5 NULL 0 0 2 1998 0 0 6.86071E-06 1 0.00221225 0.003101236 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1998,0,00 1 1 2017 1 5 7 25 25025 250250 1 3 NULL 0 0 2 1998 0 0 0.038175035 1 0.00221225 17.25620381 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1998,0,00 1 1 2017 1 5 7 25 25025 250250 1 2 NULL 0 0 2 1998 0 0 0.01716944 1 0.00221225 7.76107623 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1998,0,00 1 1 2017 1 5 7 25 25025 250250 1 1 NULL 0 0 2 1998 0 0 0.00319581 1 0.00221225 1.444597145 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1997,0,00 1 1 2017 1 5 7 25 25025 250250 1 122 NULL 0 0 2 1997 0 0 3.52041E-05 1 0.00106755 0.032976533 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1997,0,00 1 1 2017 1 5 7 25 25025 250250 1 121 NULL 0 0 2 1997 0 0 1.3196E-05 1 0.00106755 0.012361013 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1997,0,00 1 1 2017 1 5 7 25 25025 250250 1 119 NULL 0 0 2 1997 0 0 0 1 0.00106755 0 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1997,0,00 1 1 2017 1 5 7 25 25025 250250 1 118 NULL 0 0 2 1997 0 0 0.000246945 1 0.00106755 0.231319379 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1997,0,00 1 1 2017 1 5 7 25 25025 250250 1 117 NULL 0 0 2 1997 0 0 4.10474E-06 1 0.00106755 0.00384501 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1997,0,00 1 1 2017 1 5 7 25 25025 250250 1 116 NULL 0 0 2 1997 0 0 3.32004E-05 1 0.00106755 0.031099618 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1997,0,00 1 1 2017 1 5 7 25 25025 250250 1 115 NULL 0 0 2 1997 0 0 4.43166E-06 1 0.00106755 0.004151243 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1997,0,00 1 1 2017 1 5 7 25 25025 250250 1 112 NULL 0 0 2 1997 0 0 0.00026433 1 0.00106755 0.247604329 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1997,0,00 1 1 2017 1 5 7 25 25025 250250 1 111 NULL 0 0 2 1997 0 0 0.00017602 1 0.00106755 0.164882197 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1997,0,00 1 1 2017 1 5 7 25 25025 250250 1 110 NULL 0 0 2 1997 0 0 0.000511275 1 0.00106755 0.478923708 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1997,0,00 1 1 2017 1 5 7 25 25025 250250 1 107 NULL 0 0 2 1997 0 0 2.73651E-05 1 0.00106755 0.025633553 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1997,0,00 1 1 2017 1 5 7 25 25025 250250 1 106 NULL 0 0 2 1997 0 0 0.000265603 1 0.00106755 0.24879678 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1997,0,00 1 1 2017 1 5 7 25 25025 250250 1 100 NULL 0 0 2 1997 0 0 0.000555736 1 0.00106755 0.520571395 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1997,0,00 1 1 2017 1 5 7 25 25025 250250 1 98 NULL 0 0 2 1997 0 0 1.1523 1 0.00106755 1079.387344 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1997,0,00 1 1 2017 1 5 7 25 25025 250250 1 91 NULL 0 0 2 1997 0 0 1.48259E-05 1 0.00106755 0.013887822 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1997,0,00 1 1 2017 1 5 7 25 25025 250250 1 90 NULL 0 0 2 1997 0 0 1.152220011 1 0.00106755 1079.312416 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1997,0,00 1 1 2017 1 5 7 25 25025 250250 1 87 NULL 0 0 2 1997 0 0 0.001794311 1 0.00106755 1.680774379 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1997,0,00 1 1 2017 1 5 7 25 25025 250250 1 79 NULL 0 0 2 1997 0 0 0.00153899 1 0.00106755 1.441609193 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1997,0,00 1 1 2017 1 5 7 25 25025 250250 1 66 NULL 0 0 2 1997 0 0 2.57281E-07 1 0.00106755 0.000241001 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1997,0,00 1 1 2017 1 5 7 25 25025 250250 1 59 NULL 0 0 2 1997 0 0 1.54777E-06 1 0.00106755 0.001449834 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1997,0,00 1 1 2017 1 5 7 25 25025 250250 1 58 NULL 0 0 2 1997 0 0 7.10283E-07 1 0.00106755 0.000665339 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1997,0,00 1 1 2017 1 5 7 25 25025 250250 1 57 NULL 0 0 2 1997 0 0 2.65216E-06 1 0.00106755 0.002484343 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1997,0,00 1 1 2017 1 5 7 25 25025 250250 1 56 NULL 0 0 2 1997 0
0 1.05134E-07 1 0.00106755 9.84816E-05 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1997,0,00 1 1 2017 1 5 7 25 25025 250250 1 55 NULL 0 0 2 1997 0
0 4.20916E-06 1 0.00106755 0.003942822 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1997,0,00 1 1 2017 1 5 7 25 25025 250250 1 54 NULL 0 0 2 1997 0
0 1.38716E-07 1 0.00106755 0.000129939 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1997,0,00 1 1 2017 1 5 7 25 25025 250250 1 53 NULL 0 0 2 1997 0
0 2.36136E-07 1 0.00106755 0.000221194 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1997,0,00 1 1 2017 1 5 7 25 25025 250250 1 52 NULL 0 0 2 1997 0
0 4.199E-07 1 0.00106755 0.000393331 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1997,0,00 1 1 2017 1 5 7 25 25025 250250 1 51 NULL 0 0 2 1997 0
0 1.5507E-06 1 0.00106755 0.001452578 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1997,0,00 1 1 2017 1 5 7 25 25025 250250 1 36 NULL 0 0 2 1997 0
0 4.33827E-06 1 0.00106755 0.004063763 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1997,0,00 1 1 2017 1 5 7 25 25025 250250 1 35 NULL 0 0 2 1997 0
0 2.18464E-06 1 0.00106755 0.002046405 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1997,0,00 1 1 2017 1 5 7 25 25025 250250 1 31 NULL 0 0 2 1997 0
0 1.03384E-05 1 0.00106755 0.00968423 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1997,0,00 1 1 2017 1 5 7 25 25025 250250 1 5 NULL 0 0 2 1997 0
0 3.31074E-06 1 0.00106755 0.003101248 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1997,0,00 1 1 2017 1 5 7 25 25025 250250 1 3 NULL 0 0 2 1997 0
0 0.025908284 1 0.00106755 24.26891758 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1997,0,00 1 1 2017 1 5 7 25 25025 250250 1 2 NULL 0 0 2 1997 0
0 0.008285378 1 0.00106755 7.761114525 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1997,0,00 1 1 2017 1 5 7 25 25025 250250 1 1 NULL 0 0 2 1997 0
0 0.00154219 1 0.00106755 1.444606734 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1996,0,00 1 1 2017 1 5 7 25 25025 250250 1 122 NULL 0 0 2 1996 0
0 0.000824295 1 0.024996599 0.032976285 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1996,0,00 1 1 2017 1 5 7 25 25025 250250 1 121 NULL 0 0 2 1996 0
0 0.00030898 1 0.024996599 0.012360882 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1996,0,00 1 1 2017 1 5 7 25 25025 250250 1 119 NULL 0 0 2 1996 0
0 0 1 0.024996599 0 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1996,0,00 1 1 2017 1 5 7 25 25025 250250 1 118 NULL 0 0 2 1996 0
0 0.00578216 1 0.024996599 0.231317866 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1996,0,00 1 1 2017 1 5 7 25 25025 250250 1 117 NULL 0 0 2 1996 0
0 9.61119E-05 1 0.024996599 0.003844999 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1996,0,00 1 1 2017 1 5 7 25 25025 250250 1 116 NULL 0 0 2 1996 0
0 0.000777382 1 0.024996599 0.03109951 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1996,0,00 1 1 2017 1 5 7 25 25025 250250 1 115 NULL 0 0 2 1996 0
0 0.000103766 1 0.024996599 0.004151205 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1996,0,00 1 1 2017 1 5 7 25 25025 250250 1 112 NULL 0 0 2 1996 0
0 0.00618927 1 0.024996599 0.24760448 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1996,0,00 1 1 2017 1 5 7 25 25025 250250 1 111 NULL 0 0 2 1996 0
0 0.00412147 1 0.024996599 0.164881221 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1996,0,00 1 1 2017 1 5 7 25 25025 250250 1 110 NULL 0 0 2 1996 0
0 0.0119714 1 0.024996599 0.478921154 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1996,0,00 1 1 2017 1 5 7 25 25025 250250 1 107 NULL 0 0 2 1996 0
0 0.000640749 1 0.024996599 0.025633447 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1996,0,00 1 1 2017 1 5 7 25 25025 250250 1 106 NULL 0 0 2 1996 0
0 0.00621905 1 0.024996599 0.248795841 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1996,0,00	1	1	2017	1	5	7	25	25025	250250	1	100	NULL	0	0	2	1996	0	0	0.0130125	1	0.024996599	0.520570797	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1996,0,00	1	1	2017	1	5	7	25	25025	250250	1	98	NULL	0	0	2	1996	0	0	26.9810009	1	0.024996599	1079.386868	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1996,0,00	1	1	2017	1	5	7	25	25025	250250	1	91	NULL	0	0	2	1996	0	0	0.000347147	1	0.024996599	0.013887789	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1996,0,00	1	1	2017	1	5	7	25	25025	250250	1	90	NULL	0	0	2	1996	0	0	26.97909927	1	0.024996599	1079.310793	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1996,0,00	1	1	2017	1	5	7	25	25025	250250	1	87	NULL	0	0	2	1996	0	0	0.042013742	1	0.024996599	1.680778322	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1996,0,00	1	1	2017	1	5	7	25	25025	250250	1	79	NULL	0	0	2	1996	0	0	0.0360354	1	0.024996599	1.441612102	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1996,0,00	1	1	2017	1	5	7	25	25025	250250	1	66	NULL	0	0	2	1996	0	0	6.02418E-06	1	0.024996599	0.000241	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1996,0,00	1	1	2017	1	5	7	25	25025	250250	1	59	NULL	0	0	2	1996	0	0	3.62405E-05	1	0.024996599	0.001449817	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1996,0,00	1	1	2017	1	5	7	25	25025	250250	1	58	NULL	0	0	2	1996	0	0	1.66311E-05	1	0.024996599	0.000665335	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1996,0,00	1	1	2017	1	5	7	25	25025	250250	1	57	NULL	0	0	2	1996	0	0	6.20998E-05	1	0.024996599	0.00248433	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1996,0,00	1	1	2017	1	5	7	25	25025	250250	1	56	NULL	0	0	2	1996	0	0	2.4617E-06	1	0.024996599	9.84814E-05	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1996,0,00	1	1	2017	1	5	7	25	25025	250250	1	55	NULL	0	0	2	1996	0	0	9.85564E-05	1	0.024996599	0.003942792	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1996,0,00	1	1	2017	1	5	7	25	25025	250250	1	54	NULL	0	0	2	1996	0	0	3.248E-06	1	0.024996599	0.000129938	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1996,0,00	1	1	2017	1	5	7	25	25025	250250	1	53	NULL	0	0	2	1996	0	0	5.52905E-06	1	0.024996599	0.000221192	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1996,0,00	1	1	2017	1	5	7	25	25025	250250	1	52	NULL	0	0	2	1996	0	0	9.83184E-06	1	0.024996599	0.000393327	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1996,0,00	1	1	2017	1	5	7	25	25025	250250	1	51	NULL	0	0	2	1996	0	0	3.63093E-05	1	0.024996599	0.00145257	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1996,0,00	1	1	2017	1	5	7	25	25025	250250	1	36	NULL	0	0	2	1996	0	0	0.000101579	1	0.024996599	0.004063713	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1996,0,00	1	1	2017	1	5	7	25	25025	250250	1	35	NULL	0	0	2	1996	0	0	5.11528E-05	1	0.024996599	0.00204639	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1996,0,00	1	1	2017	1	5	7	25	25025	250250	1	31	NULL	0	0	2	1996	0	0	0.000242072	1	0.024996599	0.009684197	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1996,0,00	1	1	2017	1	5	7	25	25025	250250	1	5	NULL	0	0	2	1996	0	0	7.75208E-05	1	0.024996599	0.003101255	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1996,0,00	1	1	2017	1	5	7	25	25025	250250	1	3	NULL	0	0	2	1996	0	0	0.606635988	1	0.024996599	24.26874085	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1996,0,00	1	1	2017	1	5	7	25	25025	250250	1	2	NULL	0	0	2	1996	0	0	0.194000646	1	0.024996599	7.76108162	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1996,0,00	1	1	2017	1	5	7	25	25025	250250	1	1	NULL	0	0	2	1996	0	0	0.036110099	1	0.024996599	1.444600489	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1995,0,00	1	1	2017	1	5	7	25	25025	250250	1	122	NULL	0	0	2	1995	0	0	0.000604286	1	0.0130891	0.046167115	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1995,0,00	1	1	2017	1	5	7	25	25025	250250	1	121	NULL	0	0	2	1995	0	0	0.000226512	1	0.0130891	0.017305392	g	mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1995,0,00	1	1	2017	1	5	7	25	25025	250250	1	119	NULL	0	0	2	1995	0	0	0	1	0.0130891	0	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1995,0,00	1	1	2017	1	5	7	25	25025	250250	1	118	NULL	0	0	2	1995	0	0	0.00423887	1	0.0130891	0.323847325	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1995,0,00	1	1	2017	1	5	7	25	25025	250250	1	117	NULL	0	0	2	1995	0	0	5.03277E-05	1	0.0130891	0.003845009	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1995,0,00	1	1	2017	1	5	7	25	25025	250250	1	116	NULL	0	0	2	1995	0	0	0.000407065	1	0.0130891	0.031099541	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1995,0,00	1	1	2017	1	5	7	25	25025	250250	1	115	NULL	0	0	2	1995	0	0	7.60704E-05	1	0.0130891	0.005811736	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1995,0,00	1	1	2017	1	5	7	25	25025	250250	1	112	NULL	0	0	2	1995	0	0	0.0045373	1	0.0130891	0.346647229	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1995,0,00	1	1	2017	1	5	7	25	25025	250250	1	111	NULL	0	0	2	1995	0	0	0.00302143	1	0.0130891	0.230835582	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1995,0,00	1	1	2017	1	5	7	25	25025	250250	1	110	NULL	0	0	2	1995	0	0	0.00877616	1	0.0130891	0.670493772	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1995,0,00	1	1	2017	1	5	7	25	25025	250250	1	107	NULL	0	0	2	1995	0	0	0.000335519	1	0.0130891	0.025633466	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1995,0,00	1	1	2017	1	5	7	25	25025	250250	1	106	NULL	0	0	2	1995	0	0	0.00325652	1	0.0130891	0.24879633	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1995,0,00	1	1	2017	1	5	7	25	25025	250250	1	100	NULL	0	0	2	1995	0	0	0.00953934	1	0.0130891	0.728800282	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1995,0,00	1	1	2017	1	5	7	25	25025	250250	1	98	NULL	0	0	2	1995	0	0	14.12849998	1	0.0130891	1079.409592	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1995,0,00	1	1	2017	1	5	7	25	25025	250250	1	91	NULL	0	0	2	1995	0	0	0.000181779	1	0.0130891	0.013887815	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1995,0,00	1	1	2017	1	5	7	25	25025	250250	1	90	NULL	0	0	2	1995	0	0	14.12720013	1	0.0130891	1079.310284	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1995,0,00	1	1	2017	1	5	7	25	25025	250250	1	87	NULL	0	0	2	1995	0	0	0.021985851	1	0.0130891	1.679706886	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1995,0,00	1	1	2017	1	5	7	25	25025	250250	1	79	NULL	0	0	2	1995	0	0	0.018857401	1	0.0130891	1.440695007	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1995,0,00	1	1	2017	1	5	7	25	25025	250250	1	66	NULL	0	0	2	1995	0	0	3.15448E-06	1	0.0130891	0.000241001	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1995,0,00	1	1	2017	1	5	7	25	25025	250250	1	59	NULL	0	0	2	1995	0	0	2.65677E-05	1	0.0130891	0.002029758	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1995,0,00	1	1	2017	1	5	7	25	25025	250250	1	58	NULL	0	0	2	1995	0	0	1.21922E-05	1	0.0130891	0.000931477	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1995,0,00	1	1	2017	1	5	7	25	25025	250250	1	57	NULL	0	0	2	1995	0	0	4.5525E-05	1	0.0130891	0.003478085	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1995,0,00	1	1	2017	1	5	7	25	25025	250250	1	56	NULL	0	0	2	1995	0	0	1.80466E-06	1	0.0130891	0.000137875	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1995,0,00	1	1	2017	1	5	7	25	25025	250250	1	55	NULL	0	0	2	1995	0	0	7.22511E-05	1	0.0130891	0.005519944	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1995,0,00	1	1	2017	1	5	7	25	25025	250250	1	54	NULL	0	0	2	1995	0	0	2.38109E-06	1	0.0130891	0.000181914	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1995,0,00	1	1	2017	1	5	7	25	25025	250250	1	53	NULL	0	0	2	1995	0	0	4.05332E-06	1	0.0130891	0.000309671	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1995,0,00	1	1	2017	1	5	7	25	25025	250250	1	52	NULL	0	0	2	1995	0	0	7.20767E-06	1	0.0130891	0.000550662	g	mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1995,0,00	1	1	2017	1	5	7	25	25025	250250	1	51	NULL	0	0	2	1995	0	0	2.66182E-05	1	0.0130891	0.002033616	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1995,0,00	1	1	2017	1	5	7	25	25025	250250	1	36	NULL	0	0	2	1995	0	0	7.44673E-05	1	0.0130891	0.005689261	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1995,0,00	1	1	2017	1	5	7	25	25025	250250	1	35	NULL	0	0	2	1995	0	0	3.74999E-05	1	0.0130891	0.002864972	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1995,0,00	1	1	2017	1	5	7	25	25025	250250	1	31	NULL	0	0	2	1995	0	0	0.000126758	1	0.0130891	0.009684241	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1995,0,00	1	1	2017	1	5	7	25	25025	250250	1	5	NULL	0	0	2	1995	0	0	5.29321E-05	1	0.0130891	0.004043984	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1995,0,00	1	1	2017	1	5	7	25	25025	250250	1	3	NULL	0	0	2	1995	0	0	0.317657322	1	0.0130891	24.26884386	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1995,0,00	1	1	2017	1	5	7	25	25025	250250	1	2	NULL	0	0	2	1995	0	0	0.101585671	1	0.0130891	7.761089157	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1995,0,00	1	1	2017	1	5	7	25	25025	250250	1	1	NULL	0	0	2	1995	0	0	0.018908501	1	0.0130891	1.444599004	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1994,0,00	1	1	2017	1	5	7	25	25025	250250	1	122	NULL	0	0	2	1994	0	0	0	1	0	NULL	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1994,0,00	1	1	2017	1	5	7	25	25025	250250	1	121	NULL	0	0	2	1994	0	0	0	1	0	NULL	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1994,0,00	1	1	2017	1	5	7	25	25025	250250	1	119	NULL	0	0	2	1994	0	0	0	1	0	NULL	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1994,0,00	1	1	2017	1	5	7	25	25025	250250	1	118	NULL	0	0	2	1994	0	0	0	1	0	NULL	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1994,0,00	1	1	2017	1	5	7	25	25025	250250	1	117	NULL	0	0	2	1994	0	0	0	1	0	NULL	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1994,0,00	1	1	2017	1	5	7	25	25025	250250	1	116	NULL	0	0	2	1994	0	0	0	1	0	NULL	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1994,0,00	1	1	2017	1	5	7	25	25025	250250	1	115	NULL	0	0	2	1994	0	0	0	1	0	NULL	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1994,0,00	1	1	2017	1	5	7	25	25025	250250	1	112	NULL	0	0	2	1994	0	0	0	1	0	NULL	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1994,0,00	1	1	2017	1	5	7	25	25025	250250	1	111	NULL	0	0	2	1994	0	0	0	1	0	NULL	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1994,0,00	1	1	2017	1	5	7	25	25025	250250	1	110	NULL	0	0	2	1994	0	0	0	1	0	NULL	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1994,0,00	1	1	2017	1	5	7	25	25025	250250	1	107	NULL	0	0	2	1994	0	0	0	1	0	NULL	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1994,0,00	1	1	2017	1	5	7	25	25025	250250	1	106	NULL	0	0	2	1994	0	0	0	1	0	NULL	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1994,0,00	1	1	2017	1	5	7	25	25025	250250	1	100	NULL	0	0	2	1994	0	0	0	1	0	NULL	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1994,0,00	1	1	2017	1	5	7	25	25025	250250	1	98	NULL	0	0	2	1994	0	0	0	1	0	NULL	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1994,0,00	1	1	2017	1	5	7	25	25025	250250	1	91	NULL	0	0	2	1994	0	0	0	1	0	NULL	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1994,0,00	1	1	2017	1	5	7	25	25025	250250	1	90	NULL	0	0	2	1994	0	0	0	1	0	NULL	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1994,0,00	1	1	2017	1	5	7	25	25025	250250	1	87	NULL	0	0	2	1994	0	0	0	1	0	NULL	g	mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1994,0,00 1 1 2017 1 5 7 25 25025 250250 1 79 NULL 0 0 2 1994 0 0 0 1 0 NULL g mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1994,0,00 1 1 2017 1 5 7 25 25025 250250 1 66 NULL 0 0 2 1994 0 0 0 1 0 NULL g mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1994,0,00 1 1 2017 1 5 7 25 25025 250250 1 59 NULL 0 0 2 1994 0 0 0 1 0 NULL g mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1994,0,00 1 1 2017 1 5 7 25 25025 250250 1 58 NULL 0 0 2 1994 0 0 0 1 0 NULL g mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1994,0,00 1 1 2017 1 5 7 25 25025 250250 1 57 NULL 0 0 2 1994 0 0 0 1 0 NULL g mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1994,0,00 1 1 2017 1 5 7 25 25025 250250 1 56 NULL 0 0 2 1994 0 0 0 1 0 NULL g mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1994,0,00 1 1 2017 1 5 7 25 25025 250250 1 55 NULL 0 0 2 1994 0 0 0 1 0 NULL g mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1994,0,00 1 1 2017 1 5 7 25 25025 250250 1 54 NULL 0 0 2 1994 0 0 0 1 0 NULL g mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1994,0,00 1 1 2017 1 5 7 25 25025 250250 1 53 NULL 0 0 2 1994 0 0 0 1 0 NULL g mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1994,0,00 1 1 2017 1 5 7 25 25025 250250 1 52 NULL 0 0 2 1994 0 0 0 1 0 NULL g mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1994,0,00 1 1 2017 1 5 7 25 25025 250250 1 51 NULL 0 0 2 1994 0 0 0 1 0 NULL g mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1994,0,00 1 1 2017 1 5 7 25 25025 250250 1 36 NULL 0 0 2 1994 0 0 0 1 0 NULL g mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1994,0,00 1 1 2017 1 5 7 25 25025 250250 1 35 NULL 0 0 2 1994 0 0 0 1 0 NULL g mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1994,0,00 1 1 2017 1 5 7 25 25025 250250 1 31 NULL 0 0 2 1994 0 0 0 1 0 NULL g mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1994,0,00 1 1 2017 1 5 7 25 25025 250250 1 5 NULL 0 0 2 1994 0 0 0 1 0 NULL g mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1994,0,00 1 1 2017 1 5 7 25 25025 250250 1 3 NULL 0 0 2 1994 0 0 0 1 0 NULL g mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1994,0,00 1 1 2017 1 5 7 25 25025 250250 1 2 NULL 0 0 2 1994 0 0 0 1 0 NULL g mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1994,0,00 1 1 2017 1 5 7 25 25025 250250 1 1 NULL 0 0 2 1994 0 0 0 1 0 NULL g mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1993,0,00 1 1 2017 1 5 7 25 25025 250250 1 122 NULL 0 0 2 1993 0 0 0 1 0 NULL g mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1993,0,00 1 1 2017 1 5 7 25 25025 250250 1 121 NULL 0 0 2 1993 0 0 0 1 0 NULL g mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1993,0,00 1 1 2017 1 5 7 25 25025 250250 1 119 NULL 0 0 2 1993 0 0 0 1 0 NULL g mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1993,0,00 1 1 2017 1 5 7 25 25025 250250 1 118 NULL 0 0 2 1993 0 0 0 1 0 NULL g mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1993,0,00 1 1 2017 1 5 7 25 25025 250250 1 117 NULL 0 0 2 1993 0 0 0 1 0 NULL g mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1993,0,00 1 1 2017 1 5 7 25 25025 250250 1 116 NULL 0 0 2 1993 0 0 0 1 0 NULL g mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1993,0,00 1 1 2017 1 5 7 25 25025 250250 1 115 NULL 0 0 2 1993 0 0 0 1 0 NULL g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1993,0,00	1	1	2017	1	5	7	25	25025	250250	1	112	NULL	0	0	2	1993	0	0	0	1	0	NULL	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1993,0,00	1	1	2017	1	5	7	25	25025	250250	1	111	NULL	0	0	2	1993	0	0	0	1	0	NULL	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1993,0,00	1	1	2017	1	5	7	25	25025	250250	1	110	NULL	0	0	2	1993	0	0	0	1	0	NULL	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1993,0,00	1	1	2017	1	5	7	25	25025	250250	1	107	NULL	0	0	2	1993	0	0	0	1	0	NULL	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1993,0,00	1	1	2017	1	5	7	25	25025	250250	1	106	NULL	0	0	2	1993	0	0	0	1	0	NULL	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1993,0,00	1	1	2017	1	5	7	25	25025	250250	1	100	NULL	0	0	2	1993	0	0	0	1	0	NULL	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1993,0,00	1	1	2017	1	5	7	25	25025	250250	1	98	NULL	0	0	2	1993	0	0	0	1	0	NULL	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1993,0,00	1	1	2017	1	5	7	25	25025	250250	1	91	NULL	0	0	2	1993	0	0	0	1	0	NULL	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1993,0,00	1	1	2017	1	5	7	25	25025	250250	1	90	NULL	0	0	2	1993	0	0	0	1	0	NULL	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1993,0,00	1	1	2017	1	5	7	25	25025	250250	1	87	NULL	0	0	2	1993	0	0	0	1	0	NULL	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1993,0,00	1	1	2017	1	5	7	25	25025	250250	1	79	NULL	0	0	2	1993	0	0	0	1	0	NULL	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1993,0,00	1	1	2017	1	5	7	25	25025	250250	1	66	NULL	0	0	2	1993	0	0	0	1	0	NULL	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1993,0,00	1	1	2017	1	5	7	25	25025	250250	1	59	NULL	0	0	2	1993	0	0	0	1	0	NULL	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1993,0,00	1	1	2017	1	5	7	25	25025	250250	1	58	NULL	0	0	2	1993	0	0	0	1	0	NULL	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1993,0,00	1	1	2017	1	5	7	25	25025	250250	1	57	NULL	0	0	2	1993	0	0	0	1	0	NULL	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1993,0,00	1	1	2017	1	5	7	25	25025	250250	1	56	NULL	0	0	2	1993	0	0	0	1	0	NULL	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1993,0,00	1	1	2017	1	5	7	25	25025	250250	1	55	NULL	0	0	2	1993	0	0	0	1	0	NULL	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1993,0,00	1	1	2017	1	5	7	25	25025	250250	1	54	NULL	0	0	2	1993	0	0	0	1	0	NULL	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1993,0,00	1	1	2017	1	5	7	25	25025	250250	1	53	NULL	0	0	2	1993	0	0	0	1	0	NULL	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1993,0,00	1	1	2017	1	5	7	25	25025	250250	1	52	NULL	0	0	2	1993	0	0	0	1	0	NULL	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1993,0,00	1	1	2017	1	5	7	25	25025	250250	1	51	NULL	0	0	2	1993	0	0	0	1	0	NULL	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1993,0,00	1	1	2017	1	5	7	25	25025	250250	1	36	NULL	0	0	2	1993	0	0	0	1	0	NULL	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1993,0,00	1	1	2017	1	5	7	25	25025	250250	1	35	NULL	0	0	2	1993	0	0	0	1	0	NULL	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1993,0,00	1	1	2017	1	5	7	25	25025	250250	1	31	NULL	0	0	2	1993	0	0	0	1	0	NULL	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1993,0,00	1	1	2017	1	5	7	25	25025	250250	1	5	NULL	0	0	2	1993	0	0	0	1	0	NULL	g	mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1993,0,00	1	1	2017	1	5	7	25	25025	250250	1	3	NULL	0	0	2	1993	0	0	0	1	0	NULL	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1993,0,00	1	1	2017	1	5	7	25	25025	250250	1	2	NULL	0	0	2	1993	0	0	0	1	0	NULL	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1993,0,00	1	1	2017	1	5	7	25	25025	250250	1	1	NULL	0	0	2	1993	0	0	0	1	0	NULL	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1992,0,00	1	1	2017	1	5	7	25	25025	250250	1	122	NULL	0	0	2	1992	0	0	1.28233E-05	1	0.00060965	0.021033872	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1992,0,00	1	1	2017	1	5	7	25	25025	250250	1	121	NULL	0	0	2	1992	0	0	4.8067E-06	1	0.00060965	0.00788436	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1992,0,00	1	1	2017	1	5	7	25	25025	250250	1	119	NULL	0	0	2	1992	0	0	0	1	0.00060965	0	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1992,0,00	1	1	2017	1	5	7	25	25025	250250	1	118	NULL	0	0	2	1992	0	0	8.9951E-05	1	0.00060965	0.147545313	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1992,0,00	1	1	2017	1	5	7	25	25025	250250	1	117	NULL	0	0	2	1992	0	0	2.34411E-06	1	0.00060965	0.00384501	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1992,0,00	1	1	2017	1	5	7	25	25025	250250	1	116	NULL	0	0	2	1992	0	0	1.89599E-05	1	0.00060965	0.031099647	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1992,0,00	1	1	2017	1	5	7	25	25025	250250	1	115	NULL	0	0	2	1992	0	0	1.61426E-06	1	0.00060965	0.002647847	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1992,0,00	1	1	2017	1	5	7	25	25025	250250	1	112	NULL	0	0	2	1992	0	0	0.000108398	1	0.00060965	0.177803666	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1992,0,00	1	1	2017	1	5	7	25	25025	250250	1	111	NULL	0	0	2	1992	0	0	6.41164E-05	1	0.00060965	0.105169199	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1992,0,00	1	1	2017	1	5	7	25	25025	250250	1	110	NULL	0	0	2	1992	0	0	0.000198349	1	0.00060965	0.325348967	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1992,0,00	1	1	2017	1	5	7	25	25025	250250	1	107	NULL	0	0	2	1992	0	0	1.56275E-05	1	0.00060965	0.025633561	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1992,0,00	1	1	2017	1	5	7	25	25025	250250	1	106	NULL	0	0	2	1992	0	0	0.000151679	1	0.00060965	0.248796868	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1992,0,00	1	1	2017	1	5	7	25	25025	250250	1	100	NULL	0	0	2	1992	0	0	0.000215598	1	0.00060965	0.353642268	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1992,0,00	1	1	2017	1	5	7	25	25025	250250	1	98	NULL	0	0	2	1992	0	0	0.658064008	1	0.00060965	1079.412816	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1992,0,00	1	1	2017	1	5	7	25	25025	250250	1	91	NULL	0	0	2	1992	0	0	8.46673E-06	1	0.00060965	0.013887848	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1992,0,00	1	1	2017	1	5	7	25	25025	250250	1	90	NULL	0	0	2	1992	0	0	0.658004999	1	0.00060965	1079.316025	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1992,0,00	1	1	2017	1	5	7	25	25025	250250	1	87	NULL	0	0	2	1992	0	0	0.001024043	1	0.00060965	1.679722184	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1992,0,00	1	1	2017	1	5	7	25	25025	250250	1	79	NULL	0	0	2	1992	0	0	0.000878329	1	0.00060965	1.440710247	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1992,0,00	1	1	2017	1	5	7	25	25025	250250	1	66	NULL	0	0	2	1992	0	0	1.46926E-07	1	0.00060965	0.000241001	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1992,0,00	1	1	2017	1	5	7	25	25025	250250	1	59	NULL	0	0	2	1992	0	0	5.63782E-07	1	0.00060965	0.000924763	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1992,0,00	1	1	2017	1	5	7	25	25025	250250	1	58	NULL	0	0	2	1992	0	0	2.58724E-07	1	0.00060965	0.000424381	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1992,0,00	1	1	2017	1	5	7	25	25025	250250	1	57	NULL	0	0	2	1992	0	0	9.66065E-07	1	0.00060965	0.001584622	g	mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1992,0,00 1 1 2017 1 5 7 25 25025 250250 1 56 NULL 0 0 2 1992 0 0 3.82958E-08 1 0.00060965 6.2816E-05 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1992,0,00 1 1 2017 1 5 7 25 25025 250250 1 55 NULL 0 0 2 1992 0 0 1.53321E-06 1 0.00060965 0.002514902 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1992,0,00 1 1 2017 1 5 7 25 25025 250250 1 54 NULL 0 0 2 1992 0 0 5.0528E-08 1 0.00060965 8.28803E-05 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1992,0,00 1 1 2017 1 5 7 25 25025 250250 1 53 NULL 0 0 2 1992 0 0 8.60136E-08 1 0.00060965 0.000141087 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1992,0,00 1 1 2017 1 5 7 25 25025 250250 1 52 NULL 0 0 2 1992 0 0 1.52951E-07 1 0.00060965 0.000250883 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1992,0,00 1 1 2017 1 5 7 25 25025 250250 1 51 NULL 0 0 2 1992 0 0 5.64851E-07 1 0.00060965 0.000926517 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1992,0,00 1 1 2017 1 5 7 25 25025 250250 1 36 NULL 0 0 2 1992 0 0 1.58024E-06 1 0.00060965 0.002592045 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1992,0,00 1 1 2017 1 5 7 25 25025 250250 1 35 NULL 0 0 2 1992 0 0 7.95767E-07 1 0.00060965 0.001305285 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1992,0,00 1 1 2017 1 5 7 25 25025 250250 1 31 NULL 0 0 2 1992 0 0 5.90399E-06 1 0.00060965 0.009684229 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1992,0,00 1 1 2017 1 5 7 25 25025 250250 1 5 NULL 0 0 2 1992 0 0 2.46543E-06 1 0.00060965 0.004044003 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1992,0,00 1 1 2017 1 5 7 25 25025 250250 1 3 NULL 0 0 2 1992 0 0 0.014795481 1 0.00060965 24.26881256 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1992,0,00 1 1 2017 1 5 7 25 25025 250250 1 2 NULL 0 0 2 1992 0 0 0.004731561 1 0.00060965 7.761110751 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1992,0,00 1 1 2017 1 5 7 25 25025 250250 1 1 NULL 0 0 2 1992 0 0 0.000880705 1 0.00060965 1.444607626 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1991,0,00 1 1 2017 1 5 7 25 25025 250250 1 122 NULL 0 0 2 1991 0 0 2.62526E-05 1 0.00124811 0.021033883 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1991,0,00 1 1 2017 1 5 7 25 25025 250250 1 121 NULL 0 0 2 1991 0 0 9.84056E-06 1 0.00124811 0.007884369 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1991,0,00 1 1 2017 1 5 7 25 25025 250250 1 119 NULL 0 0 2 1991 0 0 0 1 0.00124811 0 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1991,0,00 1 1 2017 1 5 7 25 25025 250250 1 118 NULL 0 0 2 1991 0 0 0.000184153 1 0.00124811 0.147545495 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1991,0,00 1 1 2017 1 5 7 25 25025 250250 1 117 NULL 0 0 2 1991 0 0 4.79899E-06 1 0.00124811 0.003845006 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1991,0,00 1 1 2017 1 5 7 25 25025 250250 1 116 NULL 0 0 2 1991 0 0 3.88156E-05 1 0.00124811 0.031099504 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1991,0,00 1 1 2017 1 5 7 25 25025 250250 1 115 NULL 0 0 2 1991 0 0 3.3048E-06 1 0.00124811 0.002647844 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1991,0,00 1 1 2017 1 5 7 25 25025 250250 1 112 NULL 0 0 2 1991 0 0 0.000221918 1 0.00124811 0.177803245 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1991,0,00 1 1 2017 1 5 7 25 25025 250250 1 111 NULL 0 0 2 1991 0 0 0.000131263 1 0.00124811 0.105169423 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1991,0,00 1 1 2017 1 5 7 25 25025 250250 1 110 NULL 0 0 2 1991 0 0 0.000406071 1 0.00124811 0.325348728 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1991,0,00 1 1 2017 1 5 7 25 25025 250250 1 107 NULL 0 0 2 1991 0 0 3.19934E-05 1 0.00124811 0.025633479 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1991,0,00 1 1 2017 1 5 7 25 25025 250250 1 106 NULL 0 0 2 1991 0 0 0.000310525 1 0.00124811 0.248796192 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1991,0,00	1	1	2017	1	5	7	25	25025	250250	1	100	NULL	0	0	2	1991	0	0	0.000441383	1	0.00124811	0.353641105	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1991,0,00	1	1	2017	1	5	7	25	25025	250250	1	98	NULL	0	0	2	1991	0	0	1.347219944	1	0.00124811	1079.408047	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1991,0,00	1	1	2017	1	5	7	25	25025	250250	1	91	NULL	0	0	2	1991	0	0	1.73335E-05	1	0.00124811	0.013887789	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1991,0,00	1	1	2017	1	5	7	25	25025	250250	1	90	NULL	0	0	2	1991	0	0	1.347100019	1	0.00124811	1079.311962	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1991,0,00	1	1	2017	1	5	7	25	25025	250250	1	87	NULL	0	0	2	1991	0	0	0.002096462	1	0.00124811	1.67970904	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1991,0,00	1	1	2017	1	5	7	25	25025	250250	1	79	NULL	0	0	2	1991	0	0	0.00179815	1	0.00124811	1.440698382	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1991,0,00	1	1	2017	1	5	7	25	25025	250250	1	66	NULL	0	0	2	1991	0	0	3.00795E-07	1	0.00124811	0.000241	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1991,0,00	1	1	2017	1	5	7	25	25025	250250	1	59	NULL	0	0	2	1991	0	0	1.15421E-06	1	0.00124811	0.000924766	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1991,0,00	1	1	2017	1	5	7	25	25025	250250	1	58	NULL	0	0	2	1991	0	0	5.29676E-07	1	0.00124811	0.000424382	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1991,0,00	1	1	2017	1	5	7	25	25025	250250	1	57	NULL	0	0	2	1991	0	0	1.97779E-06	1	0.00124811	0.001584628	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1991,0,00	1	1	2017	1	5	7	25	25025	250250	1	56	NULL	0	0	2	1991	0	0	7.84014E-08	1	0.00124811	6.28161E-05	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1991,0,00	1	1	2017	1	5	7	25	25025	250250	1	55	NULL	0	0	2	1991	0	0	3.13888E-06	1	0.00124811	0.002514907	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1991,0,00	1	1	2017	1	5	7	25	25025	250250	1	54	NULL	0	0	2	1991	0	0	1.03444E-07	1	0.00124811	8.28805E-05	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1991,0,00	1	1	2017	1	5	7	25	25025	250250	1	53	NULL	0	0	2	1991	0	0	1.76092E-07	1	0.00124811	0.000141087	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1991,0,00	1	1	2017	1	5	7	25	25025	250250	1	52	NULL	0	0	2	1991	0	0	3.1313E-07	1	0.00124811	0.000250883	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1991,0,00	1	1	2017	1	5	7	25	25025	250250	1	51	NULL	0	0	2	1991	0	0	1.1564E-06	1	0.00124811	0.000926521	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1991,0,00	1	1	2017	1	5	7	25	25025	250250	1	36	NULL	0	0	2	1991	0	0	3.23515E-06	1	0.00124811	0.002592039	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1991,0,00	1	1	2017	1	5	7	25	25025	250250	1	35	NULL	0	0	2	1991	0	0	1.62914E-06	1	0.00124811	0.001305286	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1991,0,00	1	1	2017	1	5	7	25	25025	250250	1	31	NULL	0	0	2	1991	0	0	1.20869E-05	1	0.00124811	0.009684163	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1991,0,00	1	1	2017	1	5	7	25	25025	250250	1	5	NULL	0	0	2	1991	0	0	5.04734E-06	1	0.00124811	0.004043985	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1991,0,00	1	1	2017	1	5	7	25	25025	250250	1	3	NULL	0	0	2	1991	0	0	0.03029016	1	0.00124811	24.26882332	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1991,0,00	1	1	2017	1	5	7	25	25025	250250	1	2	NULL	0	0	2	1991	0	0	0.009686691	1	0.00124811	7.761087559	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1991,0,00	1	1	2017	1	5	7	25	25025	250250	1	1	NULL	0	0	2	1991	0	0	0.00180302	1	0.00124811	1.444600283	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1990,0,00	1	1	2017	1	5	7	25	25025	250250	1	122	NULL	0	0	2	1990	0	0	6.94593E-05	1	0.00125731	0.055244372	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1990,0,00	1	1	2017	1	5	7	25	25025	250250	1	121	NULL	0	0	2	1990	0	0	2.60363E-05	1	0.00125731	0.020707939	g	mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1990,0,00	1	1	2017	1	5	7	25	25025	250250	1	119	NULL	0	0	2	1990	0	0	0	1	0.00125731	0	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1990,0,00	1	1	2017	1	5	7	25	25025	250250	1	118	NULL	0	0	2	1990	0	0	0.000487234	1	0.00125731	0.387520971	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1990,0,00	1	1	2017	1	5	7	25	25025	250250	1	117	NULL	0	0	2	1990	0	0	4.83434E-06	1	0.00125731	0.003844986	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1990,0,00	1	1	2017	1	5	7	25	25025	250250	1	116	NULL	0	0	2	1990	0	0	3.91016E-05	1	0.00125731	0.03109941	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1990,0,00	1	1	2017	1	5	7	25	25025	250250	1	115	NULL	0	0	2	1990	0	0	8.74388E-06	1	0.00125731	0.006954434	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1990,0,00	1	1	2017	1	5	7	25	25025	250250	1	112	NULL	0	0	2	1990	0	0	0.000567515	1	0.00125731	0.451372339	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1990,0,00	1	1	2017	1	5	7	25	25025	250250	1	111	NULL	0	0	2	1990	0	0	0.000347297	1	0.00125731	0.276222242	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1990,0,00	1	1	2017	1	5	7	25	25025	250250	1	110	NULL	0	0	2	1990	0	0	0.00105475	1	0.00125731	0.838894166	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1990,0,00	1	1	2017	1	5	7	25	25025	250250	1	107	NULL	0	0	2	1990	0	0	3.22291E-05	1	0.00125731	0.025633377	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1990,0,00	1	1	2017	1	5	7	25	25025	250250	1	106	NULL	0	0	2	1990	0	0	0.000312813	1	0.00125731	0.24879544	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1990,0,00	1	1	2017	1	5	7	25	25025	250250	1	100	NULL	0	0	2	1990	0	0	0.00114647	1	0.00125731	0.911843482	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1990,0,00	1	1	2017	1	5	7	25	25025	250250	1	98	NULL	0	0	2	1990	0	0	1.357149959	1	0.00125731	1079.407558	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1990,0,00	1	1	2017	1	5	7	25	25025	250250	1	91	NULL	0	0	2	1990	0	0	1.74612E-05	1	0.00125731	0.013887713	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1990,0,00	1	1	2017	1	5	7	25	25025	250250	1	90	NULL	0	0	2	1990	0	0	1.357030034	1	0.00125731	1079.312176	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1990,0,00	1	1	2017	1	5	7	25	25025	250250	1	87	NULL	0	0	2	1990	0	0	0.002111913	1	0.00125731	1.679707183	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1990,0,00	1	1	2017	1	5	7	25	25025	250250	1	79	NULL	0	0	2	1990	0	0	0.0018114	1	0.00125731	1.440694816	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1990,0,00	1	1	2017	1	5	7	25	25025	250250	1	66	NULL	0	0	2	1990	0	0	3.03011E-07	1	0.00125731	0.000240999	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1990,0,00	1	1	2017	1	5	7	25	25025	250250	1	59	NULL	0	0	2	1990	0	0	3.05382E-06	1	0.00125731	0.002428852	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1990,0,00	1	1	2017	1	5	7	25	25025	250250	1	58	NULL	0	0	2	1990	0	0	1.40142E-06	1	0.00125731	0.001114618	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1990,0,00	1	1	2017	1	5	7	25	25025	250250	1	57	NULL	0	0	2	1990	0	0	5.23285E-06	1	0.00125731	0.004161941	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1990,0,00	1	1	2017	1	5	7	25	25025	250250	1	56	NULL	0	0	2	1990	0	0	2.07435E-07	1	0.00125731	0.000164983	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1990,0,00	1	1	2017	1	5	7	25	25025	250250	1	55	NULL	0	0	2	1990	0	0	8.30487E-06	1	0.00125731	0.006605268	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1990,0,00	1	1	2017	1	5	7	25	25025	250250	1	54	NULL	0	0	2	1990	0	0	2.73693E-07	1	0.00125731	0.000217681	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1990,0,00	1	1	2017	1	5	7	25	25025	250250	1	53	NULL	0	0	2	1990	0	0	4.65907E-07	1	0.00125731	0.000370559	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1990,0,00	1	1	2017	1	5	7	25	25025	250250	1	52	NULL	0	0	2	1990	0	0	8.28482E-07	1	0.00125731	0.000658932	g	mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1990,0,00 1 1 2017 1 5 7 25 25025 250250 1 51 NULL 0 0 2 1990 0 0 3.05961E-06 1 0.00125731 0.002433457 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1990,0,00 1 1 2017 1 5 7 25 25025 250250 1 36 NULL 0 0 2 1990 0 0 8.5596E-06 1 0.00125731 0.006807868 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1990,0,00 1 1 2017 1 5 7 25 25025 250250 1 35 NULL 0 0 2 1990 0 0 4.3104E-06 1 0.00125731 0.003428271 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1990,0,00 1 1 2017 1 5 7 25 25025 250250 1 31 NULL 0 0 2 1990 0 0 1.2176E-05 1 0.00125731 0.009684167 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1990,0,00 1 1 2017 1 5 7 25 25025 250250 1 5 NULL 0 0 2 1990 0 0 5.08453E-06 1 0.00125731 0.004043971 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1990,0,00 1 1 2017 1 5 7 25 25025 250250 1 3 NULL 0 0 2 1990 0 0 0.03245382 1 0.00125731 25.81210608 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1990,0,00 1 1 2017 1 5 7 25 25025 250250 1 2 NULL 0 0 2 1990 0 0 0.009758016 1 0.00125731 7.76102615 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1990,0,00 1 1 2017 1 5 7 25 25025 250250 1 1 NULL 0 0 2 1990 0 0 0.0018163 1 0.00125731 1.444591962 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1989,0,00 1 1 2017 1 5 7 25 25025 250250 1 122 NULL 0 0 2 1989 0 0 0 1 0 NULL g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1989,0,00 1 1 2017 1 5 7 25 25025 250250 1 121 NULL 0 0 2 1989 0 0 0 1 0 NULL g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1989,0,00 1 1 2017 1 5 7 25 25025 250250 1 119 NULL 0 0 2 1989 0 0 0 1 0 NULL g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1989,0,00 1 1 2017 1 5 7 25 25025 250250 1 118 NULL 0 0 2 1989 0 0 0 1 0 NULL g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1989,0,00 1 1 2017 1 5 7 25 25025 250250 1 117 NULL 0 0 2 1989 0 0 0 1 0 NULL g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1989,0,00 1 1 2017 1 5 7 25 25025 250250 1 116 NULL 0 0 2 1989 0 0 0 1 0 NULL g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1989,0,00 1 1 2017 1 5 7 25 25025 250250 1 115 NULL 0 0 2 1989 0 0 0 1 0 NULL g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1989,0,00 1 1 2017 1 5 7 25 25025 250250 1 112 NULL 0 0 2 1989 0 0 0 1 0 NULL g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1989,0,00 1 1 2017 1 5 7 25 25025 250250 1 111 NULL 0 0 2 1989 0 0 0 1 0 NULL g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1989,0,00 1 1 2017 1 5 7 25 25025 250250 1 110 NULL 0 0 2 1989 0 0 0 1 0 NULL g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1989,0,00 1 1 2017 1 5 7 25 25025 250250 1 107 NULL 0 0 2 1989 0 0 0 1 0 NULL g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1989,0,00 1 1 2017 1 5 7 25 25025 250250 1 106 NULL 0 0 2 1989 0 0 0 1 0 NULL g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1989,0,00 1 1 2017 1 5 7 25 25025 250250 1 100 NULL 0 0 2 1989 0 0 0 1 0 NULL g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1989,0,00 1 1 2017 1 5 7 25 25025 250250 1 98 NULL 0 0 2 1989 0 0 0 1 0 NULL g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1989,0,00 1 1 2017 1 5 7 25 25025 250250 1 91 NULL 0 0 2 1989 0 0 0 1 0 NULL g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1989,0,00 1 1 2017 1 5 7 25 25025 250250 1 90 NULL 0 0 2 1989 0 0 0 1 0 NULL g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1989,0,00 1 1 2017 1 5 7 25 25025 250250 1 87 NULL 0 0 2 1989 0 0 0 1 0 NULL g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1989,0,00	1	1	2017	1	5	7	25	25025	250250	1	79	NULL	0	0	2	1989	0	0	0	1	0	NULL	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1989,0,00	1	1	2017	1	5	7	25	25025	250250	1	66	NULL	0	0	2	1989	0	0	0	1	0	NULL	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1989,0,00	1	1	2017	1	5	7	25	25025	250250	1	59	NULL	0	0	2	1989	0	0	0	1	0	NULL	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1989,0,00	1	1	2017	1	5	7	25	25025	250250	1	58	NULL	0	0	2	1989	0	0	0	1	0	NULL	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1989,0,00	1	1	2017	1	5	7	25	25025	250250	1	57	NULL	0	0	2	1989	0	0	0	1	0	NULL	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1989,0,00	1	1	2017	1	5	7	25	25025	250250	1	56	NULL	0	0	2	1989	0	0	0	1	0	NULL	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1989,0,00	1	1	2017	1	5	7	25	25025	250250	1	55	NULL	0	0	2	1989	0	0	0	1	0	NULL	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1989,0,00	1	1	2017	1	5	7	25	25025	250250	1	54	NULL	0	0	2	1989	0	0	0	1	0	NULL	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1989,0,00	1	1	2017	1	5	7	25	25025	250250	1	53	NULL	0	0	2	1989	0	0	0	1	0	NULL	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1989,0,00	1	1	2017	1	5	7	25	25025	250250	1	52	NULL	0	0	2	1989	0	0	0	1	0	NULL	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1989,0,00	1	1	2017	1	5	7	25	25025	250250	1	51	NULL	0	0	2	1989	0	0	0	1	0	NULL	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1989,0,00	1	1	2017	1	5	7	25	25025	250250	1	36	NULL	0	0	2	1989	0	0	0	1	0	NULL	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1989,0,00	1	1	2017	1	5	7	25	25025	250250	1	35	NULL	0	0	2	1989	0	0	0	1	0	NULL	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1989,0,00	1	1	2017	1	5	7	25	25025	250250	1	31	NULL	0	0	2	1989	0	0	0	1	0	NULL	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1989,0,00	1	1	2017	1	5	7	25	25025	250250	1	5	NULL	0	0	2	1989	0	0	0	1	0	NULL	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1989,0,00	1	1	2017	1	5	7	25	25025	250250	1	3	NULL	0	0	2	1989	0	0	0	1	0	NULL	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1989,0,00	1	1	2017	1	5	7	25	25025	250250	1	2	NULL	0	0	2	1989	0	0	0	1	0	NULL	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1989,0,00	1	1	2017	1	5	7	25	25025	250250	1	1	NULL	0	0	2	1989	0	0	0	1	0	NULL	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1988,0,00	1	1	2017	1	5	7	25	25025	250250	1	122	NULL	0	0	2	1988	0	0	0	1	0	NULL	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1988,0,00	1	1	2017	1	5	7	25	25025	250250	1	121	NULL	0	0	2	1988	0	0	0	1	0	NULL	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1988,0,00	1	1	2017	1	5	7	25	25025	250250	1	119	NULL	0	0	2	1988	0	0	0	1	0	NULL	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1988,0,00	1	1	2017	1	5	7	25	25025	250250	1	118	NULL	0	0	2	1988	0	0	0	1	0	NULL	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1988,0,00	1	1	2017	1	5	7	25	25025	250250	1	117	NULL	0	0	2	1988	0	0	0	1	0	NULL	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1988,0,00	1	1	2017	1	5	7	25	25025	250250	1	116	NULL	0	0	2	1988	0	0	0	1	0	NULL	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1988,0,00	1	1	2017	1	5	7	25	25025	250250	1	115	NULL	0	0	2	1988	0	0	0	1	0	NULL	g	mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1988,0,00	1	1	2017	1	5	7	25	25025	250250	1	112	NULL	0	0	2	1988	0	0	0	1	0	NULL	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1988,0,00	1	1	2017	1	5	7	25	25025	250250	1	111	NULL	0	0	2	1988	0	0	0	1	0	NULL	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1988,0,00	1	1	2017	1	5	7	25	25025	250250	1	110	NULL	0	0	2	1988	0	0	0	1	0	NULL	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1988,0,00	1	1	2017	1	5	7	25	25025	250250	1	107	NULL	0	0	2	1988	0	0	0	1	0	NULL	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1988,0,00	1	1	2017	1	5	7	25	25025	250250	1	106	NULL	0	0	2	1988	0	0	0	1	0	NULL	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1988,0,00	1	1	2017	1	5	7	25	25025	250250	1	100	NULL	0	0	2	1988	0	0	0	1	0	NULL	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1988,0,00	1	1	2017	1	5	7	25	25025	250250	1	98	NULL	0	0	2	1988	0	0	0	1	0	NULL	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1988,0,00	1	1	2017	1	5	7	25	25025	250250	1	91	NULL	0	0	2	1988	0	0	0	1	0	NULL	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1988,0,00	1	1	2017	1	5	7	25	25025	250250	1	90	NULL	0	0	2	1988	0	0	0	1	0	NULL	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1988,0,00	1	1	2017	1	5	7	25	25025	250250	1	87	NULL	0	0	2	1988	0	0	0	1	0	NULL	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1988,0,00	1	1	2017	1	5	7	25	25025	250250	1	79	NULL	0	0	2	1988	0	0	0	1	0	NULL	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1988,0,00	1	1	2017	1	5	7	25	25025	250250	1	66	NULL	0	0	2	1988	0	0	0	1	0	NULL	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1988,0,00	1	1	2017	1	5	7	25	25025	250250	1	59	NULL	0	0	2	1988	0	0	0	1	0	NULL	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1988,0,00	1	1	2017	1	5	7	25	25025	250250	1	58	NULL	0	0	2	1988	0	0	0	1	0	NULL	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1988,0,00	1	1	2017	1	5	7	25	25025	250250	1	57	NULL	0	0	2	1988	0	0	0	1	0	NULL	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1988,0,00	1	1	2017	1	5	7	25	25025	250250	1	56	NULL	0	0	2	1988	0	0	0	1	0	NULL	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1988,0,00	1	1	2017	1	5	7	25	25025	250250	1	55	NULL	0	0	2	1988	0	0	0	1	0	NULL	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1988,0,00	1	1	2017	1	5	7	25	25025	250250	1	54	NULL	0	0	2	1988	0	0	0	1	0	NULL	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1988,0,00	1	1	2017	1	5	7	25	25025	250250	1	53	NULL	0	0	2	1988	0	0	0	1	0	NULL	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1988,0,00	1	1	2017	1	5	7	25	25025	250250	1	52	NULL	0	0	2	1988	0	0	0	1	0	NULL	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1988,0,00	1	1	2017	1	5	7	25	25025	250250	1	51	NULL	0	0	2	1988	0	0	0	1	0	NULL	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1988,0,00	1	1	2017	1	5	7	25	25025	250250	1	36	NULL	0	0	2	1988	0	0	0	1	0	NULL	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1988,0,00	1	1	2017	1	5	7	25	25025	250250	1	35	NULL	0	0	2	1988	0	0	0	1	0	NULL	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1988,0,00	1	1	2017	1	5	7	25	25025	250250	1	31	NULL	0	0	2	1988	0	0	0	1	0	NULL	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1988,0,00	1	1	2017	1	5	7	25	25025	250250	1	5	NULL	0	0	2	1988	0	0	0	1	0	NULL	g	mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1988,0,00 1 1 2017 1 5 7 25 25025 250250 1 3 NULL 0 0 2 1988 0 0 0 1 0 NULL g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1988,0,00 1 1 2017 1 5 7 25 25025 250250 1 2 NULL 0 0 2 1988 0 0 0 1 0 NULL g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1988,0,00 1 1 2017 1 5 7 25 25025 250250 1 1 NULL 0 0 2 1988 0 0 0 1 0 NULL g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1987,0,00 1 1 2017 1 5 7 25 25025 250250 1 122 NULL 0 0 2 1987 0 0 0.00068224 1 0.00680793 0.100212549 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1987,0,00 1 1 2017 1 5 7 25 25025 250250 1 121 NULL 0 0 2 1987 0 0 0.000255732 1 0.00680793 0.037563844 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1987,0,00 1 1 2017 1 5 7 25 25025 250250 1 119 NULL 0 0 2 1987 0 0 0 1 0.00680793 0 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1987,0,00 1 1 2017 1 5 7 25 25025 250250 1 118 NULL 0 0 2 1987 0 0 0.00478568 1 0.00680793 0.702956747 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1987,0,00 1 1 2017 1 5 7 25 25025 250250 1 117 NULL 0 0 2 1987 0 0 2.61765E-05 1 0.00680793 0.003845001 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1987,0,00 1 1 2017 1 5 7 25 25025 250250 1 116 NULL 0 0 2 1987 0 0 0.000211723 1 0.00680793 0.031099469 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1987,0,00 1 1 2017 1 5 7 25 25025 250250 1 115 NULL 0 0 2 1987 0 0 8.58836E-05 1 0.00680793 0.01261523 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1987,0,00 1 1 2017 1 5 7 25 25025 250250 1 112 NULL 0 0 2 1987 0 0 0.00674812 1 0.00680793 0.991214657 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1987,0,00 1 1 2017 1 5 7 25 25025 250250 1 111 NULL 0 0 2 1987 0 0 0.0034112 1 0.00680793 0.501062728 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1987,0,00 1 1 2017 1 5 7 25 25025 250250 1 110 NULL 0 0 2 1987 0 0 0.0115338 1 0.00680793 1.694171335 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1987,0,00 1 1 2017 1 5 7 25 25025 250250 1 107 NULL 0 0 2 1987 0 0 0.000174511 1 0.00680793 0.025633491 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1987,0,00 1 1 2017 1 5 7 25 25025 250250 1 106 NULL 0 0 2 1987 0 0 0.00169378 1 0.00680793 0.248795154 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1987,0,00 1 1 2017 1 5 7 25 25025 250250 1 100 NULL 0 0 2 1987 0 0 0.0125368 1 0.00680793 1.841499521 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1987,0,00 1 1 2017 1 5 7 25 25025 250250 1 98 NULL 0 0 2 1987 0 0 7.348519802 1 0.00680793 1079.405925 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1987,0,00 1 1 2017 1 5 7 25 25025 250250 1 91 NULL 0 0 2 1987 0 0 9.45468E-05 1 0.00680793 0.013887751 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1987,0,00 1 1 2017 1 5 7 25 25025 250250 1 90 NULL 0 0 2 1987 0 0 7.347859859 1 0.00680793 1079.308988 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1987,0,00 1 1 2017 1 5 7 25 25025 250250 1 87 NULL 0 0 2 1987 0 0 0.01143531 1 0.00680793 1.679704496 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1987,0,00 1 1 2017 1 5 7 25 25025 250250 1 79 NULL 0 0 2 1987 0 0 0.00980817 1 0.00680793 1.440697821 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1987,0,00 1 1 2017 1 5 7 25 25025 250250 1 66 NULL 0 0 2 1987 0 0 1.64071E-06 1 0.00680793 0.000241 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1987,0,00 1 1 2017 1 5 7 25 25025 250250 1 59 NULL 0 0 2 1987 0 0 2.9995E-05 1 0.00680793 0.004405892 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1987,0,00 1 1 2017 1 5 7 25 25025 250250 1 58 NULL 0 0 2 1987 0 0 1.3765E-05 1 0.00680793 0.002021907 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1987,0,00 1 1 2017 1 5 7 25 25025 250250 1 57 NULL 0 0 2 1987 0 0 5.13978E-05 1 0.00680793 0.007549696 g mi

1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1987,0,00	1	1	2017	1	5	7	25	25025	250250	1	56	NULL	0	0	2	1987	0	0	2.03746E-06	1	0.00680793	0.000299277	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1987,0,00	1	1	2017	1	5	7	25	25025	250250	1	55	NULL	0	0	2	1987	0	0	8.15716E-05	1	0.00680793	0.011981851	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1987,0,00	1	1	2017	1	5	7	25	25025	250250	1	54	NULL	0	0	2	1987	0	0	2.68825E-06	1	0.00680793	0.00039487	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1987,0,00	1	1	2017	1	5	7	25	25025	250250	1	53	NULL	0	0	2	1987	0	0	4.5762E-06	1	0.00680793	0.000672187	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1987,0,00	1	1	2017	1	5	7	25	25025	250250	1	52	NULL	0	0	2	1987	0	0	8.13747E-06	1	0.00680793	0.001195293	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1987,0,00	1	1	2017	1	5	7	25	25025	250250	1	51	NULL	0	0	2	1987	0	0	3.00519E-05	1	0.00680793	0.004414249	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1987,0,00	1	1	2017	1	5	7	25	25025	250250	1	36	NULL	0	0	2	1987	0	0	8.40736E-05	1	0.00680793	0.012349364	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1987,0,00	1	1	2017	1	5	7	25	25025	250250	1	35	NULL	0	0	2	1987	0	0	4.23374E-05	1	0.00680793	0.006218836	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1987,0,00	1	1	2017	1	5	7	25	25025	250250	1	31	NULL	0	0	2	1987	0	0	6.59291E-05	1	0.00680793	0.009684163	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1987,0,00	1	1	2017	1	5	7	25	25025	250250	1	5	NULL	0	0	2	1987	0	0	2.75311E-05	1	0.00680793	0.004043976	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1987,0,00	1	1	2017	1	5	7	25	25025	250250	1	3	NULL	0	0	2	1987	0	0	0.227540314	1	0.00680793	33.42283479	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1987,0,00	1	1	2017	1	5	7	25	25025	250250	1	2	NULL	0	0	2	1987	0	0	0.052836664	1	0.00680793	7.761047087	g	mi
1,1,2017,1,5,7,25,25025,250250,1,0,0,2,1987,0,00	1	1	2017	1	5	7	25	25025	250250	1	1	NULL	0	0	2	1987	0	0	0.00983473	1	0.00680793	1.44459921	g	mi

Source: KBE and Massport, 2019.

Table I-10 MOVES2014b Sample Input File for the Future Planning Horizon


```
<runspec version="MOVES2014b-20181203">
    <description><![CDATA[ESPR BOS]]></description>
    <models>
        <model value="ONROAD"/>
    </models>
    <modelscale value="Inv"/>
    <modeldomain value="PROJECT"/>
    <geographicselections>
        <geographicselection type="COUNTY" key="25025" description="MASSACHUSETTS - Suffolk County"/>
    </geographicselections>
    <timespan>
        <year key="2035"/>
        <month id="1"/>
        <day id="5"/>
        <beginhour id="7"/>
        <endhour id="7"/>
        <aggregateBy key="Hour"/>
    </timespan>
    <onroadvehicleselections>
        <onroadvehicleselection fueltypeid="3" fueltypedesc="Compressed Natural Gas (CNG)" sourcetypeid="42" sourcetypename="Transit Bus"/>
        <onroadvehicleselection fueltypeid="2" fueltypedesc="Diesel Fuel" sourcetypeid="42" sourcetypename="Transit Bus"/>
    </onroadvehicleselections>
    <offroadvehicleselections>
    </offroadvehicleselections>
    <offroadvehiclesccs>
    </offroadvehiclesccs>
    <roadtypes separateramps="false">
        <roadtype roadtypeid="1" roadtypename="Off-Network" modelCombination="M1"/>
        <roadtype roadtypeid="5" roadtypename="Urban Unrestricted Access" modelCombination="M1"/>
    </roadtypes>
    <pollutantprocessassociations>
        <pollutantprocessassociation pollutantkey="58" pollutantname="Aluminum" processkey="1" processname="Running Exhaust"/>
        <pollutantprocessassociation pollutantkey="58" pollutantname="Aluminum" processkey="2" processname="Start Exhaust"/>
        <pollutantprocessassociation pollutantkey="58" pollutantname="Aluminum" processkey="15" processname="Crankcase Running Exhaust"/>
        <pollutantprocessassociation pollutantkey="58" pollutantname="Aluminum" processkey="16" processname="Crankcase Start Exhaust"/>
        <pollutantprocessassociation pollutantkey="58" pollutantname="Aluminum" processkey="17" processname="Crankcase Extended Idle Exhaust"/>
        <pollutantprocessassociation pollutantkey="58" pollutantname="Aluminum" processkey="90" processname="Extended Idle Exhaust"/>
        <pollutantprocessassociation pollutantkey="58" pollutantname="Aluminum" processkey="91" processname="Auxiliary Power Exhaust"/>
```

<pollutantprocessassociation pollutantkey="36" pollutantname="Ammonium (NH4)" processkey="1" processname="Running Exhaust"/>
<pollutantprocessassociation pollutantkey="36" pollutantname="Ammonium (NH4)" processkey="2" processname="Start Exhaust"/>
<pollutantprocessassociation pollutantkey="36" pollutantname="Ammonium (NH4)" processkey="15" processname="Crankcase Running Exhaust"/>
<pollutantprocessassociation pollutantkey="36" pollutantname="Ammonium (NH4)" processkey="16" processname="Crankcase Start Exhaust"/>
<pollutantprocessassociation pollutantkey="36" pollutantname="Ammonium (NH4)" processkey="17" processname="Crankcase Extended Idle Exhaust"/>
<pollutantprocessassociation pollutantkey="36" pollutantname="Ammonium (NH4)" processkey="90" processname="Extended Idle Exhaust"/>
<pollutantprocessassociation pollutantkey="36" pollutantname="Ammonium (NH4)" processkey="91" processname="Auxiliary Power Exhaust"/>
<pollutantprocessassociation pollutantkey="90" pollutantname="Atmospheric CO2" processkey="1" processname="Running Exhaust"/>
<pollutantprocessassociation pollutantkey="90" pollutantname="Atmospheric CO2" processkey="2" processname="Start Exhaust"/>
<pollutantprocessassociation pollutantkey="90" pollutantname="Atmospheric CO2" processkey="90" processname="Extended Idle Exhaust"/>
<pollutantprocessassociation pollutantkey="90" pollutantname="Atmospheric CO2" processkey="91" processname="Auxiliary Power Exhaust"/>
<pollutantprocessassociation pollutantkey="121" pollutantname="CMAQ5.0 Unspeciated (PMOTHR)" processkey="1" processname="Running Exhaust"/>
<pollutantprocessassociation pollutantkey="121" pollutantname="CMAQ5.0 Unspeciated (PMOTHR)" processkey="2" processname="Start Exhaust"/>
<pollutantprocessassociation pollutantkey="121" pollutantname="CMAQ5.0 Unspeciated (PMOTHR)" processkey="15" processname="Crankcase Running Exhaust"/>
<pollutantprocessassociation pollutantkey="121" pollutantname="CMAQ5.0 Unspeciated (PMOTHR)" processkey="16" processname="Crankcase Start Exhaust"/>
<pollutantprocessassociation pollutantkey="121" pollutantname="CMAQ5.0 Unspeciated (PMOTHR)" processkey="17" processname="Crankcase Extended Idle Exhaust"/>
<pollutantprocessassociation pollutantkey="121" pollutantname="CMAQ5.0 Unspeciated (PMOTHR)" processkey="90" processname="Extended Idle Exhaust"/>
<pollutantprocessassociation pollutantkey="121" pollutantname="CMAQ5.0 Unspeciated (PMOTHR)" processkey="91" processname="Auxiliary Power Exhaust"/>
<pollutantprocessassociation pollutantkey="98" pollutantname="CO2 Equivalent" processkey="1" processname="Running Exhaust"/>
<pollutantprocessassociation pollutantkey="98" pollutantname="CO2 Equivalent" processkey="2" processname="Start Exhaust"/>
<pollutantprocessassociation pollutantkey="98" pollutantname="CO2 Equivalent" processkey="90" processname="Extended Idle Exhaust"/>
<pollutantprocessassociation pollutantkey="98" pollutantname="CO2 Equivalent" processkey="91" processname="Auxiliary Power Exhaust"/>
<pollutantprocessassociation pollutantkey="55" pollutantname="Calcium" processkey="1" processname="Running Exhaust"/>
<pollutantprocessassociation pollutantkey="55" pollutantname="Calcium" processkey="2" processname="Start Exhaust"/>
<pollutantprocessassociation pollutantkey="55" pollutantname="Calcium" processkey="15" processname="Crankcase Running Exhaust"/>
<pollutantprocessassociation pollutantkey="55" pollutantname="Calcium" processkey="16" processname="Crankcase Start Exhaust"/>
<pollutantprocessassociation pollutantkey="55" pollutantname="Calcium" processkey="17" processname="Crankcase Extended Idle Exhaust"/>

<pollutantprocessassociation pollutantkey="55" pollutantname="Calcium" processkey="90" processname="Extended Idle Exhaust"/>
<pollutantprocessassociation pollutantkey="55" pollutantname="Calcium" processkey="91" processname="Auxiliary Power Exhaust"/>
<pollutantprocessassociation pollutantkey="2" pollutantname="Carbon Monoxide (CO)" processkey="1" processname="Running Exhaust"/>
<pollutantprocessassociation pollutantkey="2" pollutantname="Carbon Monoxide (CO)" processkey="2" processname="Start Exhaust"/>
<pollutantprocessassociation pollutantkey="2" pollutantname="Carbon Monoxide (CO)" processkey="15" processname="Crankcase Running Exhaust"/>
<pollutantprocessassociation pollutantkey="2" pollutantname="Carbon Monoxide (CO)" processkey="16" processname="Crankcase Start Exhaust"/>
<pollutantprocessassociation pollutantkey="2" pollutantname="Carbon Monoxide (CO)" processkey="17" processname="Crankcase Extended Idle Exhaust"/>
<pollutantprocessassociation pollutantkey="2" pollutantname="Carbon Monoxide (CO)" processkey="90" processname="Extended Idle Exhaust"/>
<pollutantprocessassociation pollutantkey="2" pollutantname="Carbon Monoxide (CO)" processkey="91" processname="Auxiliary Power Exhaust"/>
<pollutantprocessassociation pollutantkey="51" pollutantname="Chloride" processkey="1" processname="Running Exhaust"/>
<pollutantprocessassociation pollutantkey="51" pollutantname="Chloride" processkey="2" processname="Start Exhaust"/>
<pollutantprocessassociation pollutantkey="51" pollutantname="Chloride" processkey="15" processname="Crankcase Running Exhaust"/>
<pollutantprocessassociation pollutantkey="51" pollutantname="Chloride" processkey="16" processname="Crankcase Start Exhaust"/>
<pollutantprocessassociation pollutantkey="51" pollutantname="Chloride" processkey="17" processname="Crankcase Extended Idle Exhaust"/>
<pollutantprocessassociation pollutantkey="51" pollutantname="Chloride" processkey="90" processname="Extended Idle Exhaust"/>
<pollutantprocessassociation pollutantkey="51" pollutantname="Chloride" processkey="91" processname="Auxiliary Power Exhaust"/>
<pollutantprocessassociation pollutantkey="118" pollutantname="Composite - NonECPM" processkey="1" processname="Running Exhaust"/>
<pollutantprocessassociation pollutantkey="118" pollutantname="Composite - NonECPM" processkey="2" processname="Start Exhaust"/>
<pollutantprocessassociation pollutantkey="118" pollutantname="Composite - NonECPM" processkey="15" processname="Crankcase Running Exhaust"/>
<pollutantprocessassociation pollutantkey="118" pollutantname="Composite - NonECPM" processkey="16" processname="Crankcase Start Exhaust"/>
<pollutantprocessassociation pollutantkey="118" pollutantname="Composite - NonECPM" processkey="17" processname="Crankcase Extended Idle Exhaust"/>
<pollutantprocessassociation pollutantkey="118" pollutantname="Composite - NonECPM" processkey="90" processname="Extended Idle Exhaust"/>
<pollutantprocessassociation pollutantkey="118" pollutantname="Composite - NonECPM" processkey="91" processname="Auxiliary Power Exhaust"/>
<pollutantprocessassociation pollutantkey="112" pollutantname="Elemental Carbon" processkey="1" processname="Running Exhaust"/>
<pollutantprocessassociation pollutantkey="112" pollutantname="Elemental Carbon" processkey="2" processname="Start Exhaust"/>
<pollutantprocessassociation pollutantkey="112" pollutantname="Elemental Carbon" processkey="15" processname="Crankcase Running Exhaust"/>

<pollutantprocessassociation pollutantkey="112" pollutantname="Elemental Carbon" processkey="16" processname="Crankcase Start Exhaust"/>
<pollutantprocessassociation pollutantkey="112" pollutantname="Elemental Carbon" processkey="17" processname="Crankcase Extended Idle Exhaust"/>
<pollutantprocessassociation pollutantkey="112" pollutantname="Elemental Carbon" processkey="90" processname="Extended Idle Exhaust"/>
<pollutantprocessassociation pollutantkey="112" pollutantname="Elemental Carbon" processkey="91" processname="Auxiliary Power Exhaust"/>
<pollutantprocessassociation pollutantkey="119" pollutantname="H2O (aerosol)" processkey="1" processname="Running Exhaust"/>
<pollutantprocessassociation pollutantkey="119" pollutantname="H2O (aerosol)" processkey="2" processname="Start Exhaust"/>
<pollutantprocessassociation pollutantkey="119" pollutantname="H2O (aerosol)" processkey="15" processname="Crankcase Running Exhaust"/>
<pollutantprocessassociation pollutantkey="119" pollutantname="H2O (aerosol)" processkey="16" processname="Crankcase Start Exhaust"/>
<pollutantprocessassociation pollutantkey="119" pollutantname="H2O (aerosol)" processkey="17" processname="Crankcase Extended Idle Exhaust"/>
<pollutantprocessassociation pollutantkey="119" pollutantname="H2O (aerosol)" processkey="90" processname="Extended Idle Exhaust"/>
<pollutantprocessassociation pollutantkey="119" pollutantname="H2O (aerosol)" processkey="91" processname="Auxiliary Power Exhaust"/>
<pollutantprocessassociation pollutantkey="59" pollutantname="Iron" processkey="1" processname="Running Exhaust"/>
<pollutantprocessassociation pollutantkey="59" pollutantname="Iron" processkey="2" processname="Start Exhaust"/>
<pollutantprocessassociation pollutantkey="59" pollutantname="Iron" processkey="15" processname="Crankcase Running Exhaust"/>
<pollutantprocessassociation pollutantkey="59" pollutantname="Iron" processkey="16" processname="Crankcase Start Exhaust"/>
<pollutantprocessassociation pollutantkey="59" pollutantname="Iron" processkey="17" processname="Crankcase Extended Idle Exhaust"/>
<pollutantprocessassociation pollutantkey="59" pollutantname="Iron" processkey="90" processname="Extended Idle Exhaust"/>
<pollutantprocessassociation pollutantkey="59" pollutantname="Iron" processkey="91" processname="Auxiliary Power Exhaust"/>
<pollutantprocessassociation pollutantkey="54" pollutantname="Magnesium" processkey="1" processname="Running Exhaust"/>
<pollutantprocessassociation pollutantkey="54" pollutantname="Magnesium" processkey="2" processname="Start Exhaust"/>
<pollutantprocessassociation pollutantkey="54" pollutantname="Magnesium" processkey="15" processname="Crankcase Running Exhaust"/>
<pollutantprocessassociation pollutantkey="54" pollutantname="Magnesium" processkey="16" processname="Crankcase Start Exhaust"/>
<pollutantprocessassociation pollutantkey="54" pollutantname="Magnesium" processkey="17" processname="Crankcase Extended Idle Exhaust"/>
<pollutantprocessassociation pollutantkey="54" pollutantname="Magnesium" processkey="90" processname="Extended Idle Exhaust"/>
<pollutantprocessassociation pollutantkey="54" pollutantname="Magnesium" processkey="91" processname="Auxiliary Power Exhaust"/>
<pollutantprocessassociation pollutantkey="66" pollutantname="Manganese Compounds" processkey="1" processname="Running Exhaust"/>
<pollutantprocessassociation pollutantkey="5" pollutantname="Methane (CH4)" processkey="1" processname="Running Exhaust"/>
<pollutantprocessassociation pollutantkey="5" pollutantname="Methane (CH4)" processkey="2" processname="Start Exhaust"/>
<pollutantprocessassociation pollutantkey="5" pollutantname="Methane (CH4)" processkey="15" processname="Crankcase Running Exhaust"/>

<pollutantprocessassociation pollutantkey="5" pollutantname="Methane (CH4)" processkey="16" processname="Crankcase Start Exhaust"/>
<pollutantprocessassociation pollutantkey="5" pollutantname="Methane (CH4)" processkey="17" processname="Crankcase Extended Idle Exhaust"/>
<pollutantprocessassociation pollutantkey="5" pollutantname="Methane (CH4)" processkey="90" processname="Extended Idle Exhaust"/>
<pollutantprocessassociation pollutantkey="5" pollutantname="Methane (CH4)" processkey="91" processname="Auxiliary Power Exhaust"/>
<pollutantprocessassociation pollutantkey="35" pollutantname="Nitrate (NO3)" processkey="1" processname="Running Exhaust"/>
<pollutantprocessassociation pollutantkey="35" pollutantname="Nitrate (NO3)" processkey="2" processname="Start Exhaust"/>
<pollutantprocessassociation pollutantkey="35" pollutantname="Nitrate (NO3)" processkey="15" processname="Crankcase Running Exhaust"/>
<pollutantprocessassociation pollutantkey="35" pollutantname="Nitrate (NO3)" processkey="16" processname="Crankcase Start Exhaust"/>
<pollutantprocessassociation pollutantkey="35" pollutantname="Nitrate (NO3)" processkey="17" processname="Crankcase Extended Idle Exhaust"/>
<pollutantprocessassociation pollutantkey="35" pollutantname="Nitrate (NO3)" processkey="90" processname="Extended Idle Exhaust"/>
<pollutantprocessassociation pollutantkey="35" pollutantname="Nitrate (NO3)" processkey="91" processname="Auxiliary Power Exhaust"/>
<pollutantprocessassociation pollutantkey="6" pollutantname="Nitrous Oxide (N2O)" processkey="1" processname="Running Exhaust"/>
<pollutantprocessassociation pollutantkey="6" pollutantname="Nitrous Oxide (N2O)" processkey="2" processname="Start Exhaust"/>
<pollutantprocessassociation pollutantkey="6" pollutantname="Nitrous Oxide (N2O)" processkey="15" processname="Crankcase Running Exhaust"/>
<pollutantprocessassociation pollutantkey="6" pollutantname="Nitrous Oxide (N2O)" processkey="16" processname="Crankcase Start Exhaust"/>
<pollutantprocessassociation pollutantkey="79" pollutantname="Non-Methane Hydrocarbons" processkey="1" processname="Running Exhaust"/>
<pollutantprocessassociation pollutantkey="79" pollutantname="Non-Methane Hydrocarbons" processkey="2" processname="Start Exhaust"/>
<pollutantprocessassociation pollutantkey="79" pollutantname="Non-Methane Hydrocarbons" processkey="11" processname="Evap Permeation"/>
<pollutantprocessassociation pollutantkey="79" pollutantname="Non-Methane Hydrocarbons" processkey="13" processname="Evap Fuel Leaks"/>
<pollutantprocessassociation pollutantkey="79" pollutantname="Non-Methane Hydrocarbons" processkey="90" processname="Extended Idle Exhaust"/>
<pollutantprocessassociation pollutantkey="79" pollutantname="Non-Methane Hydrocarbons" processkey="91" processname="Auxiliary Power Exhaust"/>
<pollutantprocessassociation pollutantkey="122" pollutantname="Non-carbon Organic Matter (NCOM)" processkey="1" processname="Running Exhaust"/>
<pollutantprocessassociation pollutantkey="122" pollutantname="Non-carbon Organic Matter (NCOM)" processkey="2" processname="Start Exhaust"/>
<pollutantprocessassociation pollutantkey="122" pollutantname="Non-carbon Organic Matter (NCOM)" processkey="15" processname="Crankcase Running Exhaust"/>
<pollutantprocessassociation pollutantkey="122" pollutantname="Non-carbon Organic Matter (NCOM)" processkey="16" processname="Crankcase Start Exhaust"/>
<pollutantprocessassociation pollutantkey="122" pollutantname="Non-carbon Organic Matter (NCOM)" processkey="17" processname="Crankcase Extended Idle Exhaust"/>

<pollutantprocessassociation pollutantkey="122" pollutantname="Non-carbon Organic Matter (NCOM)" processkey="90" processname="Extended Idle Exhaust"/>

<pollutantprocessassociation pollutantkey="122" pollutantname="Non-carbon Organic Matter (NCOM)" processkey="91" processname="Auxiliary Power Exhaust"/>

<pollutantprocessassociation pollutantkey="111" pollutantname="Organic Carbon" processkey="1" processname="Running Exhaust"/>

<pollutantprocessassociation pollutantkey="111" pollutantname="Organic Carbon" processkey="2" processname="Start Exhaust"/>

<pollutantprocessassociation pollutantkey="111" pollutantname="Organic Carbon" processkey="15" processname="Crankcase Running Exhaust"/>

<pollutantprocessassociation pollutantkey="111" pollutantname="Organic Carbon" processkey="16" processname="Crankcase Start Exhaust"/>

<pollutantprocessassociation pollutantkey="111" pollutantname="Organic Carbon" processkey="17" processname="Crankcase Extended Idle Exhaust"/>

<pollutantprocessassociation pollutantkey="111" pollutantname="Organic Carbon" processkey="90" processname="Extended Idle Exhaust"/>

<pollutantprocessassociation pollutantkey="111" pollutantname="Organic Carbon" processkey="91" processname="Auxiliary Power Exhaust"/>

<pollutantprocessassociation pollutantkey="3" pollutantname="Oxides of Nitrogen (NOx)" processkey="1" processname="Running Exhaust"/>

<pollutantprocessassociation pollutantkey="3" pollutantname="Oxides of Nitrogen (NOx)" processkey="2" processname="Start Exhaust"/>

<pollutantprocessassociation pollutantkey="3" pollutantname="Oxides of Nitrogen (NOx)" processkey="15" processname="Crankcase Running Exhaust"/>

<pollutantprocessassociation pollutantkey="3" pollutantname="Oxides of Nitrogen (NOx)" processkey="16" processname="Crankcase Start Exhaust"/>

<pollutantprocessassociation pollutantkey="3" pollutantname="Oxides of Nitrogen (NOx)" processkey="17" processname="Crankcase Extended Idle Exhaust"/>

<pollutantprocessassociation pollutantkey="3" pollutantname="Oxides of Nitrogen (NOx)" processkey="90" processname="Extended Idle Exhaust"/>

<pollutantprocessassociation pollutantkey="3" pollutantname="Oxides of Nitrogen (NOx)" processkey="91" processname="Auxiliary Power Exhaust"/>

<pollutantprocessassociation pollutantkey="53" pollutantname="Potassium" processkey="1" processname="Running Exhaust"/>

<pollutantprocessassociation pollutantkey="53" pollutantname="Potassium" processkey="2" processname="Start Exhaust"/>

<pollutantprocessassociation pollutantkey="53" pollutantname="Potassium" processkey="15" processname="Crankcase Running Exhaust"/>

<pollutantprocessassociation pollutantkey="53" pollutantname="Potassium" processkey="16" processname="Crankcase Start Exhaust"/>

<pollutantprocessassociation pollutantkey="53" pollutantname="Potassium" processkey="17" processname="Crankcase Extended Idle Exhaust"/>

<pollutantprocessassociation pollutantkey="53" pollutantname="Potassium" processkey="90" processname="Extended Idle Exhaust"/>

<pollutantprocessassociation pollutantkey="53" pollutantname="Potassium" processkey="91" processname="Auxiliary Power Exhaust"/>

<pollutantprocessassociation pollutantkey="100" pollutantname="Primary Exhaust PM10 - Total" processkey="1" processname="Running Exhaust"/>

<pollutantprocessassociation pollutantkey="100" pollutantname="Primary Exhaust PM10 - Total" processkey="2" processname="Start Exhaust"/>

<pollutantprocessassociation pollutantkey="100" pollutantname="Primary Exhaust PM10 - Total" processkey="15" processname="Crankcase Running Exhaust"/>

<pollutantprocessassociation pollutantkey="100" pollutantname="Primary Exhaust PM10 - Total" processkey="16" processname="Crankcase Start Exhaust"/>
<pollutantprocessassociation pollutantkey="100" pollutantname="Primary Exhaust PM10 - Total" processkey="17" processname="Crankcase Extended Idle Exhaust"/>
<pollutantprocessassociation pollutantkey="100" pollutantname="Primary Exhaust PM10 - Total" processkey="90" processname="Extended Idle Exhaust"/>
<pollutantprocessassociation pollutantkey="100" pollutantname="Primary Exhaust PM10 - Total" processkey="91" processname="Auxiliary Power Exhaust"/>
<pollutantprocessassociation pollutantkey="110" pollutantname="Primary Exhaust PM2.5 - Total" processkey="1" processname="Running Exhaust"/>
<pollutantprocessassociation pollutantkey="110" pollutantname="Primary Exhaust PM2.5 - Total" processkey="2" processname="Start Exhaust"/>
<pollutantprocessassociation pollutantkey="110" pollutantname="Primary Exhaust PM2.5 - Total" processkey="15" processname="Crankcase Running Exhaust"/>
<pollutantprocessassociation pollutantkey="110" pollutantname="Primary Exhaust PM2.5 - Total" processkey="16" processname="Crankcase Start Exhaust"/>
<pollutantprocessassociation pollutantkey="110" pollutantname="Primary Exhaust PM2.5 - Total" processkey="17" processname="Crankcase Extended Idle Exhaust"/>
<pollutantprocessassociation pollutantkey="110" pollutantname="Primary Exhaust PM2.5 - Total" processkey="90" processname="Extended Idle Exhaust"/>
<pollutantprocessassociation pollutantkey="110" pollutantname="Primary Exhaust PM2.5 - Total" processkey="91" processname="Auxiliary Power Exhaust"/>
<pollutantprocessassociation pollutantkey="106" pollutantname="Primary PM10 - Brakewear Particulate" processkey="9" processname="Brakewear"/>
<pollutantprocessassociation pollutantkey="107" pollutantname="Primary PM10 - Tirewear Particulate" processkey="10" processname="Tirewear"/>
<pollutantprocessassociation pollutantkey="116" pollutantname="Primary PM2.5 - Brakewear Particulate" processkey="9" processname="Brakewear"/>
<pollutantprocessassociation pollutantkey="117" pollutantname="Primary PM2.5 - Tirewear Particulate" processkey="10" processname="Tirewear"/>
<pollutantprocessassociation pollutantkey="57" pollutantname="Silicon" processkey="1" processname="Running Exhaust"/>
<pollutantprocessassociation pollutantkey="57" pollutantname="Silicon" processkey="2" processname="Start Exhaust"/>
<pollutantprocessassociation pollutantkey="57" pollutantname="Silicon" processkey="15" processname="Crankcase Running Exhaust"/>
<pollutantprocessassociation pollutantkey="57" pollutantname="Silicon" processkey="16" processname="Crankcase Start Exhaust"/>
<pollutantprocessassociation pollutantkey="57" pollutantname="Silicon" processkey="17" processname="Crankcase Extended Idle Exhaust"/>
<pollutantprocessassociation pollutantkey="57" pollutantname="Silicon" processkey="90" processname="Extended Idle Exhaust"/>
<pollutantprocessassociation pollutantkey="57" pollutantname="Silicon" processkey="91" processname="Auxiliary Power Exhaust"/>
<pollutantprocessassociation pollutantkey="52" pollutantname="Sodium" processkey="1" processname="Running Exhaust"/>
<pollutantprocessassociation pollutantkey="52" pollutantname="Sodium" processkey="2" processname="Start Exhaust"/>
<pollutantprocessassociation pollutantkey="52" pollutantname="Sodium" processkey="15" processname="Crankcase Running Exhaust"/>
<pollutantprocessassociation pollutantkey="52" pollutantname="Sodium" processkey="16" processname="Crankcase Start Exhaust"/>
<pollutantprocessassociation pollutantkey="52" pollutantname="Sodium" processkey="17" processname="Crankcase Extended Idle Exhaust"/>

<pollutantprocessassociation pollutantkey="52" pollutantname="Sodium" processkey="90" processname="Extended Idle Exhaust"/>
<pollutantprocessassociation pollutantkey="52" pollutantname="Sodium" processkey="91" processname="Auxiliary Power Exhaust"/>
<pollutantprocessassociation pollutantkey="115" pollutantname="Sulfate Particulate" processkey="1" processname="Running Exhaust"/>
<pollutantprocessassociation pollutantkey="115" pollutantname="Sulfate Particulate" processkey="2" processname="Start Exhaust"/>
<pollutantprocessassociation pollutantkey="115" pollutantname="Sulfate Particulate" processkey="15" processname="Crankcase Running Exhaust"/>
<pollutantprocessassociation pollutantkey="115" pollutantname="Sulfate Particulate" processkey="16" processname="Crankcase Start Exhaust"/>
<pollutantprocessassociation pollutantkey="115" pollutantname="Sulfate Particulate" processkey="17" processname="Crankcase Extended Idle Exhaust"/>
<pollutantprocessassociation pollutantkey="115" pollutantname="Sulfate Particulate" processkey="90" processname="Extended Idle Exhaust"/>
<pollutantprocessassociation pollutantkey="115" pollutantname="Sulfate Particulate" processkey="91" processname="Auxiliary Power Exhaust"/>
<pollutantprocessassociation pollutantkey="31" pollutantname="Sulfur Dioxide (SO2)" processkey="1" processname="Running Exhaust"/>
<pollutantprocessassociation pollutantkey="31" pollutantname="Sulfur Dioxide (SO2)" processkey="2" processname="Start Exhaust"/>
<pollutantprocessassociation pollutantkey="31" pollutantname="Sulfur Dioxide (SO2)" processkey="15" processname="Crankcase Running Exhaust"/>
<pollutantprocessassociation pollutantkey="31" pollutantname="Sulfur Dioxide (SO2)" processkey="16" processname="Crankcase Start Exhaust"/>
<pollutantprocessassociation pollutantkey="31" pollutantname="Sulfur Dioxide (SO2)" processkey="17" processname="Crankcase Extended Idle Exhaust"/>
<pollutantprocessassociation pollutantkey="31" pollutantname="Sulfur Dioxide (SO2)" processkey="90" processname="Extended Idle Exhaust"/>
<pollutantprocessassociation pollutantkey="31" pollutantname="Sulfur Dioxide (SO2)" processkey="91" processname="Auxiliary Power Exhaust"/>
<pollutantprocessassociation pollutantkey="56" pollutantname="Titanium" processkey="1" processname="Running Exhaust"/>
<pollutantprocessassociation pollutantkey="56" pollutantname="Titanium" processkey="2" processname="Start Exhaust"/>
<pollutantprocessassociation pollutantkey="56" pollutantname="Titanium" processkey="15" processname="Crankcase Running Exhaust"/>
<pollutantprocessassociation pollutantkey="56" pollutantname="Titanium" processkey="16" processname="Crankcase Start Exhaust"/>
<pollutantprocessassociation pollutantkey="56" pollutantname="Titanium" processkey="17" processname="Crankcase Extended Idle Exhaust"/>
<pollutantprocessassociation pollutantkey="56" pollutantname="Titanium" processkey="90" processname="Extended Idle Exhaust"/>
<pollutantprocessassociation pollutantkey="56" pollutantname="Titanium" processkey="91" processname="Auxiliary Power Exhaust"/>
<pollutantprocessassociation pollutantkey="91" pollutantname="Total Energy Consumption" processkey="1" processname="Running Exhaust"/>
<pollutantprocessassociation pollutantkey="91" pollutantname="Total Energy Consumption" processkey="2" processname="Start Exhaust"/>
<pollutantprocessassociation pollutantkey="91" pollutantname="Total Energy Consumption" processkey="90" processname="Extended Idle Exhaust"/>

<pollutantprocessassociation pollutantkey="91" pollutantname="Total Energy Consumption" processkey="91" processname="Auxiliary Power Exhaust"/>
<pollutantprocessassociation pollutantkey="1" pollutantname="Total Gaseous Hydrocarbons" processkey="1" processname="Running Exhaust"/>
<pollutantprocessassociation pollutantkey="1" pollutantname="Total Gaseous Hydrocarbons" processkey="2" processname="Start Exhaust"/>
<pollutantprocessassociation pollutantkey="1" pollutantname="Total Gaseous Hydrocarbons" processkey="11" processname="Evap Permeation"/>
<pollutantprocessassociation pollutantkey="1" pollutantname="Total Gaseous Hydrocarbons" processkey="13" processname="Evap Fuel Leaks"/>
<pollutantprocessassociation pollutantkey="1" pollutantname="Total Gaseous Hydrocarbons" processkey="90" processname="Extended Idle Exhaust"/>
<pollutantprocessassociation pollutantkey="1" pollutantname="Total Gaseous Hydrocarbons" processkey="91" processname="Auxiliary Power Exhaust"/>
<pollutantprocessassociation pollutantkey="87" pollutantname="Volatile Organic Compounds" processkey="1" processname="Running Exhaust"/>
<pollutantprocessassociation pollutantkey="87" pollutantname="Volatile Organic Compounds" processkey="2" processname="Start Exhaust"/>
<pollutantprocessassociation pollutantkey="87" pollutantname="Volatile Organic Compounds" processkey="11" processname="Evap Permeation"/>
<pollutantprocessassociation pollutantkey="87" pollutantname="Volatile Organic Compounds" processkey="13" processname="Evap Fuel Leaks"/>
<pollutantprocessassociation pollutantkey="87" pollutantname="Volatile Organic Compounds" processkey="15" processname="Crankcase Running Exhaust"/>
<pollutantprocessassociation pollutantkey="87" pollutantname="Volatile Organic Compounds" processkey="16" processname="Crankcase Start Exhaust"/>
<pollutantprocessassociation pollutantkey="87" pollutantname="Volatile Organic Compounds" processkey="17" processname="Crankcase Extended Idle Exhaust"/>
<pollutantprocessassociation pollutantkey="87" pollutantname="Volatile Organic Compounds" processkey="90" processname="Extended Idle Exhaust"/>
<pollutantprocessassociation pollutantkey="87" pollutantname="Volatile Organic Compounds" processkey="91" processname="Auxiliary Power Exhaust"/>
</pollutantprocessassociations>
<databaseselections>
<databaseselection servername="" databasename="mylevs" description=""/>
</databaseselections>
<internalcontrolstrategies>
<internalcontrolstrategy classname="gov.epa.otaq.moves.master.implementation.ghg.internalcontrolstrategies.rateofprogress.RateOfProgressStrategy"><![CDATA[
useParameters No

]]></internalcontrolstrategy>
</internalcontrolstrategies>
<inputdatabase servername="" databasename="" description=""/>
<uncertaintyparameters uncertaintymodeenabled="false" numberofrunspersimulation="0" numberofsimulations="0"/>
<geographicoutputdetail description="LINK"/>
<outputemissionsbreakdownselection>
<modelyear selected="true"/>
<fueltype selected="true"/>

```xml
        <fuelsubtype selected="false"/>
        <emissionprocess selected="false"/>
        <onroadoffroad selected="true"/>
        <roadtype selected="false"/>
        <sourceusetype selected="true"/>
        <movesvehicletype selected="false"/>
        <onroadscc selected="false"/>
        <estimateuncertainty selected="false" numberOfIterations="2" keepSampledData="false" keepIterations="false"/>
        <sector selected="false"/>
        <engtechid selected="false"/>
        <hpclass selected="false"/>
        <regclassid selected="false"/>
    </outputemissionsbreakdownselection>
    <outputdatabase servername="" databasename="ESPR2035w_out" description=""/>
    <outputtimestep value="Hour"/>
    <outputvmtdata value="true"/>
    <outputsho value="true"/>
    <outputsh value="true"/>
    <outputshp value="true"/>
    <outputshidling value="true"/>
    <outputstarts value="true"/>
    <outputpopulation value="true"/>
    <scaleinputdatabase servername="localhost" databasename="espr2035w_input" description=""/>
    <pmsize value="0"/>
    <outputfactors>
        <timefactors selected="true" units="Hours"/>
        <distancefactors selected="true" units="Miles"/>
        <massfactors selected="true" units="Grams" energyunits="Million BTU"/>
    </outputfactors>
    <savedata>

    </savedata>

    <donotexecute>

    </donotexecute>

    <generatordatabase shouldsave="false" servername="" databasename="" description=""/>
        <donotperformfinalaggregation selected="false"/>
    <lookuptableflags scenarioid="" truncateoutput="true" truncateactivity="true" truncatebaserates="true"/>
</runspec>
```


Source: KBE and Massport, 2019.

Table I-11 MOVES2014b Sample Output File for the Future Planning Horizon

MasterKey MOVESRunID iterationID yearID monthID dayID hourID stateID countyID zoneID linkID pollutantID processID sourceTypeID regClassId fuelTypeID modelYearID roadTypeID SCCemissionQuant activityTypeID activity emissionRate massUnits distanceUnits

1,1,2035,7,5,16,25,25025,250250,22,31,0,0,0,0,0,00 1 1 2035 7 5 16 25 25025 250250 22 122 NULL 31 0 0 0 0 0 0.00168011 1 0 NULL g mi

1,1,2035,7,5,16,25,25025,250250,22,31,0,0,0,0,0,00 1 1 2035 7 5 16 25 25025 250250 22 121 NULL 31 0 0 0 0 0 0.00065387 1 0 NULL g mi

1,1,2035,7,5,16,25,25025,250250,22,31,0,0,0,0,0,00 1 1 2035 7 5 16 25 25025 250250 22 119 NULL 31 0 0 0 0 0 0 1 0 NULL g mi

1,1,2035,7,5,16,25,25025,250250,22,31,0,0,0,0,0,00 1 1 2035 7 5 16 25 25025 250250 22 118 NULL 31 0 0 0 0 0 0.0156419 1 0 NULL g mi

1,1,2035,7,5,16,25,25025,250250,22,31,0,0,0,0,0,00 1 1 2035 7 5 16 25 25025 250250 22 117 NULL 31 0 0 0 0 0 0 1 0 NULL g mi

1,1,2035,7,5,16,25,25025,250250,22,31,0,0,0,0,0,00 1 1 2035 7 5 16 25 25025 250250 22 116 NULL 31 0 0 0 0 0 0 1 0 NULL g mi

1,1,2035,7,5,16,25,25025,250250,22,31,0,0,0,0,0,00 1 1 2035 7 5 16 25 25025 250250 22 115 NULL 31 0 0 0 0 0 0.00380871 1 0 NULL g mi

1,1,2035,7,5,16,25,25025,250250,22,31,0,0,0,0,0,00 1 1 2035 7 5 16 25 25025 250250 22 112 NULL 31 0 0 0 0 0 0.00239617 1 0 NULL g mi

1,1,2035,7,5,16,25,25025,250250,22,31,0,0,0,0,0,00 1 1 2035 7 5 16 25 25025 250250 22 111 NULL 31 0 0 0 0 0 0.00840052 1 0 NULL g mi

1,1,2035,7,5,16,25,25025,250250,22,31,0,0,0,0,0,00 1 1 2035 7 5 16 25 25025 250250 22 110 NULL 31 0 0 0 0 0 0.018038001 1 0 NULL g mi

1,1,2035,7,5,16,25,25025,250250,22,31,0,0,0,0,0,00 1 1 2035 7 5 16 25 25025 250250 22 107 NULL 31 0 0 0 0 0 0 1 0 NULL g mi

1,1,2035,7,5,16,25,25025,250250,22,31,0,0,0,0,0,00 1 1 2035 7 5 16 25 25025 250250 22 106 NULL 31 0 0 0 0 0 0 1 0 NULL g mi

1,1,2035,7,5,16,25,25025,250250,22,31,0,0,0,0,0,00 1 1 2035 7 5 16 25 25025 250250 22 100 NULL 31 0 0 0 0 0 0.0201692 1 0 NULL g mi

1,1,2035,7,5,16,25,25025,250250,22,31,0,0,0,0,0,00 1 1 2035 7 5 16 25 25025 250250 22 98 NULL 31 0 0 0 0 0 2794.060059 1 0 NULL g mi

1,1,2035,7,5,16,25,25025,250250,22,31,0,0,0,0,0,00 1 1 2035 7 5 16 25 25025 250250 22 91 NULL 31 0 0 0 0 0 0.036830559 1 0 NULL g mi

1,1,2035,7,5,16,25,25025,250250,22,31,0,0,0,0,0,00 1 1 2035 7 5 16 25 25025 250250 22 90 NULL 31 0 0 0 0 0 2793.76001 1 0 NULL g mi

1,1,2035,7,5,16,25,25025,250250,22,31,0,0,0,0,0,00 1 1 2035 7 5 16 25 25025 250250 22 87 NULL 31 0 0 0 0 0 0.350133657 1 0 NULL g mi

1,1,2035,7,5,16,25,25025,250250,22,31,0,0,0,0,0,00 1 1 2035 7 5 16 25 25025 250250 22 79 NULL 31 0 0 0 0 0 0.312041998 1 0 NULL g mi

1,1,2035,7,5,16,25,25025,250250,22,31,0,0,0,0,0,00 1 1 2035 7 5 16 25 25025 250250 22 66 NULL 31 0 0 0 0 0 0.00079204 1 0 NULL g mi

1,1,2035,7,5,16,25,25025,250250,22,31,0,0,0,0,0,00 1 1 2035 7 5 16 25 25025 250250 22 59 NULL 31 0 0 0 0 0 0.000271367 1 0 NULL g mi

1,1,2035,7,5,16,25,25025,250250,22,31,0,0,0,0,0,00 1 1 2035 7 5 16 25 25025 250250 22 58 NULL 31 0 0 0 0 0 4.79254E-05 1 0 NULL g mi

1,1,2035,7,5,16,25,25025,250250,22,31,0,0,0,0,0,00 1 1 2035 7 5 16 25 25025 250250 22 57 NULL 31 0 0 0 0 0 4.78272E-05 1 0 NULL g mi

1,1,2035,7,5,16,25,25025,250250,22,31,0,0,0,0,0,00 1 1 2035 7 5 16 25 25025 250250 22 56 NULL 31 0 0 0 0 0 5.23052E-06 1 0 NULL g mi

1,1,2035,7,5,16,25,25025,250250,22,31,0,0,0,0,0,00 1 1 2035 7 5 16 25 25025 250250 22 55 NULL 31 0 0 0 0 0 0.00021377 1 0 NULL g mi

1,1,2035,7,5,16,25,25025,250250,22,31,0,0,0,0,0,00 1 1 2035 7 5 16 25 25025 250250 22 54 NULL 31 0 0 0 0 0 2.44654E-05 1 0 NULL g mi

1,1,2035,7,5,16,25,25025,250250,22,31,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	22	53	NULL	31	0	0	0	0	0	1.32841E-05	1	0	NULL	g	mi
1,1,2035,7,5,16,25,25025,250250,22,31,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	22	52	NULL	31	0	0	0	0	0	3.96295E-05	1	0	NULL	g	mi
1,1,2035,7,5,16,25,25025,250250,22,31,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	22	51	NULL	31	0	0	0	0	0	1.59874E-05	1	0	NULL	g	mi
1,1,2035,7,5,16,25,25025,250250,22,31,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	22	36	NULL	31	0	0	0	0	0	0.000379312	1	0	NULL	g	mi
1,1,2035,7,5,16,25,25025,250250,22,31,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	22	35	NULL	31	0	0	0	0	0	3.98675E-05	1	0	NULL	g	mi
1,1,2035,7,5,16,25,25025,250250,22,31,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	22	31	NULL	31	0	0	0	0	0	0.0189596	1	0	NULL	g	mi
1,1,2035,7,5,16,25,25025,250250,22,31,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	22	5	NULL	31	0	0	0	0	0	0.011918506	1	0	NULL	g	mi
1,1,2035,7,5,16,25,25025,250250,22,31,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	22	3	NULL	31	0	0	0	0	0	0.156248242	1	0	NULL	g	mi
1,1,2035,7,5,16,25,25025,250250,22,31,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	22	2	NULL	31	0	0	0	0	0	1.613148451	1	0	NULL	g	mi
1,1,2035,7,5,16,25,25025,250250,22,31,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	22	1	NULL	31	0	0	0	0	0	0.323915005	1	0	NULL	g	mi
1,1,2035,7,5,16,25,25025,250250,21,21,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	21	122	NULL	21	0	0	0	0	0	0.00288659	1	0	NULL	g	mi
1,1,2035,7,5,16,25,25025,250250,21,21,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	21	121	NULL	21	0	0	0	0	0	0.00118465	1	0	NULL	g	mi
1,1,2035,7,5,16,25,25025,250250,21,21,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	21	119	NULL	21	0	0	0	0	0	0	1	0	NULL	g	mi
1,1,2035,7,5,16,25,25025,250250,21,21,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	21	118	NULL	21	0	0	0	0	0	0.0212365	1	0	NULL	g	mi
1,1,2035,7,5,16,25,25025,250250,21,21,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	21	117	NULL	21	0	0	0	0	0	0	1	0	NULL	g	mi
1,1,2035,7,5,16,25,25025,250250,21,21,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	21	116	NULL	21	0	0	0	0	0	0	1	0	NULL	g	mi
1,1,2035,7,5,16,25,25025,250250,21,21,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	21	115	NULL	21	0	0	0	0	0	0.000817467	1	0	NULL	g	mi
1,1,2035,7,5,16,25,25025,250250,21,21,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	21	112	NULL	21	0	0	0	0	0	0.00364177	1	0	NULL	g	mi
1,1,2035,7,5,16,25,25025,250250,21,21,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	21	111	NULL	21	0	0	0	0	0	0.0144329	1	0	NULL	g	mi
1,1,2035,7,5,16,25,25025,250250,21,21,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	21	110	NULL	21	0	0	0	0	0	0.024878301	1	0	NULL	g	mi
1,1,2035,7,5,16,25,25025,250250,21,21,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	21	107	NULL	21	0	0	0	0	0	0	1	0	NULL	g	mi
1,1,2035,7,5,16,25,25025,250250,21,21,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	21	106	NULL	21	0	0	0	0	0	0	1	0	NULL	g	mi
1,1,2035,7,5,16,25,25025,250250,21,21,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	21	100	NULL	21	0	0	0	0	0	0.028109301	1	0	NULL	g	mi
1,1,2035,7,5,16,25,25025,250250,21,21,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	21	98	NULL	21	0	0	0	0	0	2169.879883	1	0	NULL	g	mi
1,1,2035,7,5,16,25,25025,250250,21,21,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	21	91	NULL	21	0	0	0	0	0	0.028612323	1	0	NULL	g	mi
1,1,2035,7,5,16,25,25025,250250,21,21,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	21	90	NULL	21	0	0	0	0	0	2169.790039	1	0	NULL	g	mi
1,1,2035,7,5,16,25,25025,250250,21,21,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	21	87	NULL	21	0	0	0	0	0	0.474752486	1	0	NULL	g	mi

1,1,2035,7,5,16,25,25025,250250,21,21,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	21	79	NULL	21	0	0	0	0	0	0.43170321	1	0	NULL	g	mi
1,1,2035,7,5,16,25,25025,250250,21,21,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	21	66	NULL	21	0	0	0	0	0	0.000795978	1	0	NULL	g	mi
1,1,2035,7,5,16,25,25025,250250,21,21,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	21	59	NULL	21	0	0	0	0	0	0.000473403	1	0	NULL	g	mi
1,1,2035,7,5,16,25,25025,250250,21,21,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	21	58	NULL	21	0	0	0	0	0	8.38885E-05	1	0	NULL	g	mi
1,1,2035,7,5,16,25,25025,250250,21,21,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	21	57	NULL	21	0	0	0	0	0	8.38744E-05	1	0	NULL	g	mi
1,1,2035,7,5,16,25,25025,250250,21,21,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	21	56	NULL	21	0	0	0	0	0	8.83026E-06	1	0	NULL	g	mi
1,1,2035,7,5,16,25,25025,250250,21,21,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	21	55	NULL	21	0	0	0	0	0	0.000373692	1	0	NULL	g	mi
1,1,2035,7,5,16,25,25025,250250,21,21,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	21	54	NULL	21	0	0	0	0	0	3.76232E-05	1	0	NULL	g	mi
1,1,2035,7,5,16,25,25025,250250,21,21,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	21	53	NULL	21	0	0	0	0	0	2.20884E-05	1	0	NULL	g	mi
1,1,2035,7,5,16,25,25025,250250,21,21,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	21	52	NULL	21	0	0	0	0	0	1.21947E-05	1	0	NULL	g	mi
1,1,2035,7,5,16,25,25025,250250,21,21,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	21	51	NULL	21	0	0	0	0	0	2.70625E-05	1	0	NULL	g	mi
1,1,2035,7,5,16,25,25025,250250,21,21,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	21	36	NULL	21	0	0	0	0	0	0.000717679	1	0	NULL	g	mi
1,1,2035,7,5,16,25,25025,250250,21,21,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	21	35	NULL	21	0	0	0	0	0	7.45783E-05	1	0	NULL	g	mi
1,1,2035,7,5,16,25,25025,250250,21,21,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	21	31	NULL	21	0	0	0	0	0	0.014551	1	0	NULL	g	mi
1,1,2035,7,5,16,25,25025,250250,21,21,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	21	5	NULL	21	0	0	0	0	0	0.003961123	1	0	NULL	g	mi
1,1,2035,7,5,16,25,25025,250250,21,21,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	21	3	NULL	21	0	0	0	0	0	0.058679447	1	0	NULL	g	mi
1,1,2035,7,5,16,25,25025,250250,21,21,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	21	2	NULL	21	0	0	0	0	0	0.360723495	1	0	NULL	g	mi
1,1,2035,7,5,16,25,25025,250250,21,21,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	21	1	NULL	21	0	0	0	0	0	0.435614794	1	0	NULL	g	mi
1,1,2035,7,5,16,25,25025,250250,20,31,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	20	122	NULL	31	0	0	0	0	0	0.000241829	1	1	0.000241829	g	mi
1,1,2035,7,5,16,25,25025,250250,20,31,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	20	121	NULL	31	0	0	0	0	0	9.85119E-05	1	1	9.85119E-05	g	mi
1,1,2035,7,5,16,25,25025,250250,20,31,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	20	119	NULL	31	0	0	0	0	0	0	1	1	0	g	mi
1,1,2035,7,5,16,25,25025,250250,20,31,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	20	118	NULL	31	0	0	0	0	0	0.00184712	1	1	0.00184712	g	mi
1,1,2035,7,5,16,25,25025,250250,20,31,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	20	117	NULL	31	0	0	0	0	0	0.00124394	1	1	0.00124394	g	mi
1,1,2035,7,5,16,25,25025,250250,20,31,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	20	116	NULL	31	0	0	0	0	0	0.00139998	1	1	0.00139998	g	mi
1,1,2035,7,5,16,25,25025,250250,20,31,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	20	115	NULL	31	0	0	0	0	0	0.000137519	1	1	0.000137519	g	mi
1,1,2035,7,5,16,25,25025,250250,20,31,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	20	112	NULL	31	0	0	0	0	0	0.000312754	1	1	0.000312754	g	mi
1,1,2035,7,5,16,25,25025,250250,20,31,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	20	111	NULL	31	0	0	0	0	0	0.00120914	1	1	0.00120914	g	mi

1,1,2035,7,5,16,25,25025,250250,20,31,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	20	110	NULL	31	0	0	0	0	0	0.00215987	1	1	0.00215987	g	mi
1,1,2035,7,5,16,25,25025,250250,20,31,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	20	107	NULL	31	0	0	0	0	0	0.00829296	1	1	0.00829296	g	mi
1,1,2035,7,5,16,25,25025,250250,20,31,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	20	106	NULL	31	0	0	0	0	0	0.0111998	1	1	0.0111998	g	mi
1,1,2035,7,5,16,25,25025,250250,20,31,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	20	100	NULL	31	0	0	0	0	0	0.00243596	1	1	0.00243596	g	mi
1,1,2035,7,5,16,25,25025,250250,20,31,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	20	98	NULL	31	0	0	0	0	0	249.3829956	1	1	249.3829956	g	mi
1,1,2035,7,5,16,25,25025,250250,20,31,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	20	91	NULL	31	0	0	0	0	0	0.003287058	1	1	0.003287058	g	mi
1,1,2035,7,5,16,25,25025,250250,20,31,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	20	90	NULL	31	0	0	0	0	0	249.3439941	1	1	249.3439941	g	mi
1,1,2035,7,5,16,25,25025,250250,20,31,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	20	87	NULL	31	0	0	0	0	0	0.04174022	1	1	0.04174022	g	mi
1,1,2035,7,5,16,25,25025,250250,20,31,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	20	79	NULL	31	0	0	0	0	0	0.037842542	1	1	0.037842542	g	mi
1,1,2035,7,5,16,25,25025,250250,20,31,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	20	66	NULL	31	0	0	0	0	0	1.58408E-05	1	1	1.58408E-05	g	mi
1,1,2035,7,5,16,25,25025,250250,20,31,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	20	59	NULL	31	0	0	0	0	0	3.95885E-05	1	1	3.95885E-05	g	mi
1,1,2035,7,5,16,25,25025,250250,20,31,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	20	58	NULL	31	0	0	0	0	0	7.01034E-06	1	1	7.01034E-06	g	mi
1,1,2035,7,5,16,25,25025,250250,20,31,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	20	57	NULL	31	0	0	0	0	0	7.00048E-06	1	1	7.00048E-06	g	mi
1,1,2035,7,5,16,25,25025,250250,20,31,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	20	56	NULL	31	0	0	0	0	0	7.41663E-07	1	1	7.41663E-07	g	mi
1,1,2035,7,5,16,25,25025,250250,20,31,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	20	55	NULL	31	0	0	0	0	0	3.12306E-05	1	1	3.12306E-05	g	mi
1,1,2035,7,5,16,25,25025,250250,20,31,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	20	54	NULL	31	0	0	0	0	0	3.20625E-06	1	1	3.20625E-06	g	mi
1,1,2035,7,5,16,25,25025,250250,20,31,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	20	53	NULL	31	0	0	0	0	0	1.85947E-06	1	1	1.85947E-06	g	mi
1,1,2035,7,5,16,25,25025,250250,20,31,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	20	52	NULL	31	0	0	0	0	0	1.69457E-06	1	1	1.69457E-06	g	mi
1,1,2035,7,5,16,25,25025,250250,20,31,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	20	51	NULL	31	0	0	0	0	0	2.26781E-06	1	1	2.26781E-06	g	mi
1,1,2035,7,5,16,25,25025,250250,20,31,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	20	36	NULL	31	0	0	0	0	0	5.93447E-05	1	1	5.93447E-05	g	mi
1,1,2035,7,5,16,25,25025,250250,20,31,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	20	35	NULL	31	0	0	0	0	0	6.17012E-06	1	1	6.17012E-06	g	mi
1,1,2035,7,5,16,25,25025,250250,20,31,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	20	31	NULL	31	0	0	0	0	0	0.00169248	1	1	0.00169248	g	mi
1,1,2035,7,5,16,25,25025,250250,20,31,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	20	5	NULL	31	0	0	0	0	0	0.001594883	1	1	0.001594883	g	mi
1,1,2035,7,5,16,25,25025,250250,20,31,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	20	3	NULL	31	0	0	0	0	0	0.03442128	1	1	0.03442128	g	mi
1,1,2035,7,5,16,25,25025,250250,20,31,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	20	2	NULL	31	0	0	0	0	0	0.920191288	1	1	0.920191288	g	mi
1,1,2035,7,5,16,25,25025,250250,20,31,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	20	1	NULL	31	0	0	0	0	0	0.039421961	1	1	0.039421961	g	mi
1,1,2035,7,5,16,25,25025,250250,19,31,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	19	122	NULL	31	0	0	0	0	0	0.00024179	1	1	0.00024179	g	mi

1,1,2035,7,5,16,25,25025,250250,19,31,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	19	121	NULL	31	0	0	0	0	0	9.84852E-05	1	1	9.84852E-05	g	mi
1,1,2035,7,5,16,25,25025,250250,19,31,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	19	119	NULL	31	0	0	0	0	0	0	1	1	0	g	mi
1,1,2035,7,5,16,25,25025,250250,19,31,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	19	118	NULL	31	0	0	0	0	0	0.00184774	1	1	0.00184774	g	mi
1,1,2035,7,5,16,25,25025,250250,19,31,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	19	117	NULL	31	0	0	0	0	0	0.00134012	1	1	0.00134012	g	mi
1,1,2035,7,5,16,25,25025,250250,19,31,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	19	116	NULL	31	0	0	0	0	0	0.00219601	1	1	0.00219601	g	mi
1,1,2035,7,5,16,25,25025,250250,19,31,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	19	115	NULL	31	0	0	0	0	0	0.000138436	1	1	0.000138436	g	mi
1,1,2035,7,5,16,25,25025,250250,19,31,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	19	112	NULL	31	0	0	0	0	0	0.000312629	1	1	0.000312629	g	mi
1,1,2035,7,5,16,25,25025,250250,19,31,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	19	111	NULL	31	0	0	0	0	0	0.00120895	1	1	0.00120895	g	mi
1,1,2035,7,5,16,25,25025,250250,19,31,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	19	110	NULL	31	0	0	0	0	0	0.00216037	1	1	0.00216037	g	mi
1,1,2035,7,5,16,25,25025,250250,19,31,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	19	107	NULL	31	0	0	0	0	0	0.00893417	1	1	0.00893417	g	mi
1,1,2035,7,5,16,25,25025,250250,19,31,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	19	106	NULL	31	0	0	0	0	0	0.017568	1	1	0.017568	g	mi
1,1,2035,7,5,16,25,25025,250250,19,31,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	19	100	NULL	31	0	0	0	0	0	0.00243646	1	1	0.00243646	g	mi
1,1,2035,7,5,16,25,25025,250250,19,31,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	19	98	NULL	31	0	0	0	0	0	254.654007	1	1	254.654007	g	mi
1,1,2035,7,5,16,25,25025,250250,19,31,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	19	91	NULL	31	0	0	0	0	0	0.003356543	1	1	0.003356543	g	mi
1,1,2035,7,5,16,25,25025,250250,19,31,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	19	90	NULL	31	0	0	0	0	0	254.6139984	1	1	254.6139984	g	mi
1,1,2035,7,5,16,25,25025,250250,19,31,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	19	87	NULL	31	0	0	0	0	0	0.042410254	1	1	0.042410254	g	mi
1,1,2035,7,5,16,25,25025,250250,19,31,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	19	79	NULL	31	0	0	0	0	0	0.038430549	1	1	0.038430549	g	mi
1,1,2035,7,5,16,25,25025,250250,19,31,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	19	66	NULL	31	0	0	0	0	0	1.76009E-05	1	1	1.76009E-05	g	mi
1,1,2035,7,5,16,25,25025,250250,19,31,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	19	59	NULL	31	0	0	0	0	0	3.95786E-05	1	1	3.95786E-05	g	mi
1,1,2035,7,5,16,25,25025,250250,19,31,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	19	58	NULL	31	0	0	0	0	0	7.00878E-06	1	1	7.00878E-06	g	mi
1,1,2035,7,5,16,25,25025,250250,19,31,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	19	57	NULL	31	0	0	0	0	0	6.99994E-06	1	1	6.99994E-06	g	mi
1,1,2035,7,5,16,25,25025,250250,19,31,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	19	56	NULL	31	0	0	0	0	0	7.41567E-07	1	1	7.41567E-07	g	mi
1,1,2035,7,5,16,25,25025,250250,19,31,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	19	55	NULL	31	0	0	0	0	0	3.12243E-05	1	1	3.12243E-05	g	mi
1,1,2035,7,5,16,25,25025,250250,19,31,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	19	54	NULL	31	0	0	0	0	0	3.20629E-06	1	1	3.20629E-06	g	mi
1,1,2035,7,5,16,25,25025,250250,19,31,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	19	53	NULL	31	0	0	0	0	0	1.85928E-06	1	1	1.85928E-06	g	mi
1,1,2035,7,5,16,25,25025,250250,19,31,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	19	52	NULL	31	0	0	0	0	0	1.70364E-06	1	1	1.70364E-06	g	mi
1,1,2035,7,5,16,25,25025,250250,19,31,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	19	51	NULL	31	0	0	0	0	0	2.26817E-06	1	1	2.26817E-06	g	mi

1,1,2035,7,5,16,25,25025,250250,19,31,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	19	36	NULL	31	0	0	0	0	0	5.93218E-05	1	1	5.93218E-05	g	mi
1,1,2035,7,5,16,25,25025,250250,19,31,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	19	35	NULL	31	0	0	0	0	0	6.16881E-06	1	1	6.16881E-06	g	mi
1,1,2035,7,5,16,25,25025,250250,19,31,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	19	31	NULL	31	0	0	0	0	0	0.00172827	1	1	0.00172827	g	mi
1,1,2035,7,5,16,25,25025,250250,19,31,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	19	5	NULL	31	0	0	0	0	0	0.001618448	1	1	0.001618448	g	mi
1,1,2035,7,5,16,25,25025,250250,19,31,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	19	3	NULL	31	0	0	0	0	0	0.033051021	1	1	0.033051021	g	mi
1,1,2035,7,5,16,25,25025,250250,19,31,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	19	2	NULL	31	0	0	0	0	0	0.9141801	1	1	0.9141801	g	mi
1,1,2035,7,5,16,25,25025,250250,19,31,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	19	1	NULL	31	0	0	0	0	0	0.040033549	1	1	0.040033549	g	mi
1,1,2035,7,5,16,25,25025,250250,18,31,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	18	122	NULL	31	0	0	0	0	0	0.000249531	1	1	0.000249531	g	mi
1,1,2035,7,5,16,25,25025,250250,18,31,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	18	121	NULL	31	0	0	0	0	0	0.000101632	1	1	0.000101632	g	mi
1,1,2035,7,5,16,25,25025,250250,18,31,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	18	119	NULL	31	0	0	0	0	0	0	1	1	0	g	mi
1,1,2035,7,5,16,25,25025,250250,18,31,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	18	118	NULL	31	0	0	0	0	0	0.00190739	1	1	0.00190739	g	mi
1,1,2035,7,5,16,25,25025,250250,18,31,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	18	117	NULL	31	0	0	0	0	0	0.00144433	1	1	0.00144433	g	mi
1,1,2035,7,5,16,25,25025,250250,18,31,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	18	116	NULL	31	0	0	0	0	0	0.00307419	1	1	0.00307419	g	mi
1,1,2035,7,5,16,25,25025,250250,18,31,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	18	115	NULL	31	0	0	0	0	0	0.000143372	1	1	0.000143372	g	mi
1,1,2035,7,5,16,25,25025,250250,18,31,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	18	112	NULL	31	0	0	0	0	0	0.00032246	1	1	0.00032246	g	mi
1,1,2035,7,5,16,25,25025,250250,18,31,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	18	111	NULL	31	0	0	0	0	0	0.00124765	1	1	0.00124765	g	mi
1,1,2035,7,5,16,25,25025,250250,18,31,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	18	110	NULL	31	0	0	0	0	0	0.00222985	1	1	0.00222985	g	mi
1,1,2035,7,5,16,25,25025,250250,18,31,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	18	107	NULL	31	0	0	0	0	0	0.00962893	1	1	0.00962893	g	mi
1,1,2035,7,5,16,25,25025,250250,18,31,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	18	106	NULL	31	0	0	0	0	0	0.0245935	1	1	0.0245935	g	mi
1,1,2035,7,5,16,25,25025,250250,18,31,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	18	100	NULL	31	0	0	0	0	0	0.00251479	1	1	0.00251479	g	mi
1,1,2035,7,5,16,25,25025,250250,18,31,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	18	98	NULL	31	0	0	0	0	0	261.4689941	1	1	261.4689941	g	mi
1,1,2035,7,5,16,25,25025,250250,18,31,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	18	91	NULL	31	0	0	0	0	0	0.003446329	1	1	0.003446329	g	mi
1,1,2035,7,5,16,25,25025,250250,18,31,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	18	90	NULL	31	0	0	0	0	0	261.427002	1	1	261.427002	g	mi
1,1,2035,7,5,16,25,25025,250250,18,31,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	18	87	NULL	31	0	0	0	0	0	0.04339271	1	1	0.04339271	g	mi
1,1,2035,7,5,16,25,25025,250250,18,31,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	18	79	NULL	31	0	0	0	0	0	0.03932384	1	1	0.03932384	g	mi
1,1,2035,7,5,16,25,25025,250250,18,31,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	18	66	NULL	31	0	0	0	0	0	1.9801E-05	1	1	1.9801E-05	g	mi
1,1,2035,7,5,16,25,25025,250250,18,31,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	18	59	NULL	31	0	0	0	0	0	4.08428E-05	1	1	4.08428E-05	g	mi

1,1,2035,7,5,16,25,25025,250250,18,31,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	18	58	NULL	31	0	0	0	0	0	7.23285E-06	1	1	7.23285E-06	g	mi
1,1,2035,7,5,16,25,25025,250250,18,31,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	18	57	NULL	31	0	0	0	0	0	7.22481E-06	1	1	7.22481E-06	g	mi
1,1,2035,7,5,16,25,25025,250250,18,31,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	18	56	NULL	31	0	0	0	0	0	7.65321E-07	1	1	7.65321E-07	g	mi
1,1,2035,7,5,16,25,25025,250250,18,31,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	18	55	NULL	31	0	0	0	0	0	3.22232E-05	1	1	3.22232E-05	g	mi
1,1,2035,7,5,16,25,25025,250250,18,31,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	18	54	NULL	31	0	0	0	0	0	3.30915E-06	1	1	3.30915E-06	g	mi
1,1,2035,7,5,16,25,25025,250250,18,31,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	18	53	NULL	31	0	0	0	0	0	1.91885E-06	1	1	1.91885E-06	g	mi
1,1,2035,7,5,16,25,25025,250250,18,31,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	18	52	NULL	31	0	0	0	0	0	1.76328E-06	1	1	1.76328E-06	g	mi
1,1,2035,7,5,16,25,25025,250250,18,31,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	18	51	NULL	31	0	0	0	0	0	2.34151E-06	1	1	2.34151E-06	g	mi
1,1,2035,7,5,16,25,25025,250250,18,31,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	18	36	NULL	31	0	0	0	0	0	6.12127E-05	1	1	6.12127E-05	g	mi
1,1,2035,7,5,16,25,25025,250250,18,31,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	18	35	NULL	31	0	0	0	0	0	6.36648E-06	1	1	6.36648E-06	g	mi
1,1,2035,7,5,16,25,25025,250250,18,31,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	18	31	NULL	31	0	0	0	0	0	0.00177461	1	1	0.00177461	g	mi
1,1,2035,7,5,16,25,25025,250250,18,31,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	18	5	NULL	31	0	0	0	0	0	0.001669297	1	1	0.001669297	g	mi
1,1,2035,7,5,16,25,25025,250250,18,31,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	18	3	NULL	31	0	0	0	0	0	0.031508658	1	1	0.031508658	g	mi
1,1,2035,7,5,16,25,25025,250250,18,31,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	18	2	NULL	31	0	0	0	0	0	0.937955499	1	1	0.937955499	g	mi
1,1,2035,7,5,16,25,25025,250250,18,31,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	18	1	NULL	31	0	0	0	0	0	0.04097737	1	1	0.04097737	g	mi
1,1,2035,7,5,16,25,25025,250250,17,31,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	17	122	NULL	31	0	0	0	0	0	0.000264209	1	1	0.000264209	g	mi
1,1,2035,7,5,16,25,25025,250250,17,31,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	17	121	NULL	31	0	0	0	0	0	0.000107607	1	1	0.000107607	g	mi
1,1,2035,7,5,16,25,25025,250250,17,31,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	17	119	NULL	31	0	0	0	0	0	0	1	1	0	g	mi
1,1,2035,7,5,16,25,25025,250250,17,31,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	17	118	NULL	31	0	0	0	0	0	0.00201979	1	1	0.00201979	g	mi
1,1,2035,7,5,16,25,25025,250250,17,31,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	17	117	NULL	31	0	0	0	0	0	0.00155567	1	1	0.00155567	g	mi
1,1,2035,7,5,16,25,25025,250250,17,31,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	17	116	NULL	31	0	0	0	0	0	0.00413238	1	1	0.00413238	g	mi
1,1,2035,7,5,16,25,25025,250250,17,31,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	17	115	NULL	31	0	0	0	0	0	0.000152017	1	1	0.000152017	g	mi
1,1,2035,7,5,16,25,25025,250250,17,31,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	17	112	NULL	31	0	0	0	0	0	0.000341157	1	1	0.000341157	g	mi
1,1,2035,7,5,16,25,25025,250250,17,31,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	17	111	NULL	31	0	0	0	0	0	0.00132104	1	1	0.00132104	g	mi
1,1,2035,7,5,16,25,25025,250250,17,31,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	17	110	NULL	31	0	0	0	0	0	0.00236095	1	1	0.00236095	g	mi
1,1,2035,7,5,16,25,25025,250250,17,31,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	17	107	NULL	31	0	0	0	0	0	0.0103712	1	1	0.0103712	g	mi
1,1,2035,7,5,16,25,25025,250250,17,31,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	17	106	NULL	31	0	0	0	0	0	0.033059102	1	1	0.033059102	g	mi

1,1,2035,7,5,16,25,25025,250250,17,31,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	17	100	NULL	31	0	0	0	0	0	0.00266263	1	1	0.00266263	g	mi
1,1,2035,7,5,16,25,25025,250250,17,31,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	17	98	NULL	31	0	0	0	0	0	270.3659973	1	1	270.3659973	g	mi
1,1,2035,7,5,16,25,25025,250250,17,31,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	17	91	NULL	31	0	0	0	0	0	0.003563574	1	1	0.003563574	g	mi
1,1,2035,7,5,16,25,25025,250250,17,31,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	17	90	NULL	31	0	0	0	0	0	270.322998	1	1	270.322998	g	mi
1,1,2035,7,5,16,25,25025,250250,17,31,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	17	87	NULL	31	0	0	0	0	0	0.044744097	1	1	0.044744097	g	mi
1,1,2035,7,5,16,25,25025,250250,17,31,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	17	79	NULL	31	0	0	0	0	0	0.04056811	1	1	0.04056811	g	mi
1,1,2035,7,5,16,25,25025,250250,17,31,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	17	66	NULL	31	0	0	0	0	0	2.26297E-05	1	1	2.26297E-05	g	mi
1,1,2035,7,5,16,25,25025,250250,17,31,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	17	59	NULL	31	0	0	0	0	0	4.32424E-05	1	1	4.32424E-05	g	mi
1,1,2035,7,5,16,25,25025,250250,17,31,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	17	58	NULL	31	0	0	0	0	0	7.65806E-06	1	1	7.65806E-06	g	mi
1,1,2035,7,5,16,25,25025,250250,17,31,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	17	57	NULL	31	0	0	0	0	0	7.65074E-06	1	1	7.65074E-06	g	mi
1,1,2035,7,5,16,25,25025,250250,17,31,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	17	56	NULL	31	0	0	0	0	0	8.10344E-07	1	1	8.10344E-07	g	mi
1,1,2035,7,5,16,25,25025,250250,17,31,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	17	55	NULL	31	0	0	0	0	0	3.41182E-05	1	1	3.41182E-05	g	mi
1,1,2035,7,5,16,25,25025,250250,17,31,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	17	54	NULL	31	0	0	0	0	0	3.50377E-06	1	1	3.50377E-06	g	mi
1,1,2035,7,5,16,25,25025,250250,17,31,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	17	53	NULL	31	0	0	0	0	0	2.03173E-06	1	1	2.03173E-06	g	mi
1,1,2035,7,5,16,25,25025,250250,17,31,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	17	52	NULL	31	0	0	0	0	0	1.86927E-06	1	1	1.86927E-06	g	mi
1,1,2035,7,5,16,25,25025,250250,17,31,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	17	51	NULL	31	0	0	0	0	0	2.48001E-06	1	1	2.48001E-06	g	mi
1,1,2035,7,5,16,25,25025,250250,17,31,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	17	36	NULL	31	0	0	0	0	0	6.48082E-05	1	1	6.48082E-05	g	mi
1,1,2035,7,5,16,25,25025,250250,17,31,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	17	35	NULL	31	0	0	0	0	0	6.74154E-06	1	1	6.74154E-06	g	mi
1,1,2035,7,5,16,25,25025,250250,17,31,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	17	31	NULL	31	0	0	0	0	0	0.00183515	1	1	0.00183515	g	mi
1,1,2035,7,5,16,25,25025,250250,17,31,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	17	5	NULL	31	0	0	0	0	0	0.001747662	1	1	0.001747662	g	mi
1,1,2035,7,5,16,25,25025,250250,17,31,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	17	3	NULL	31	0	0	0	0	0	0.029629184	1	1	0.029629184	g	mi
1,1,2035,7,5,16,25,25025,250250,17,31,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	17	2	NULL	31	0	0	0	0	0	0.98750627	1	1	0.98750627	g	mi
1,1,2035,7,5,16,25,25025,250250,17,31,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	17	1	NULL	31	0	0	0	0	0	0.042299379	1	1	0.042299379	g	mi
1,1,2035,7,5,16,25,25025,250250,16,31,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	16	122	NULL	31	0	0	0	0	0	0.000283937	1	1	0.000283937	g	mi
1,1,2035,7,5,16,25,25025,250250,16,31,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	16	121	NULL	31	0	0	0	0	0	0.000115616	1	1	0.000115616	g	mi
1,1,2035,7,5,16,25,25025,250250,16,31,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	16	119	NULL	31	0	0	0	0	0	0	1	1	0	g	mi
1,1,2035,7,5,16,25,25025,250250,16,31,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	16	118	NULL	31	0	0	0	0	0	0.00217298	1	1	0.00217298	g	mi

1,1,2035,7,5,16,25,25025,250250,16,31,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	16	117	NULL	31	0	0	0	0	0	0.00167614	1	1	0.00167614	g	mi
1,1,2035,7,5,16,25,25025,250250,16,31,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	16	116	NULL	31	0	0	0	0	0	0.00553225	1	1	0.00553225	g	mi
1,1,2035,7,5,16,25,25025,250250,16,31,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	16	115	NULL	31	0	0	0	0	0	0.000165785	1	1	0.000165785	g	mi
1,1,2035,7,5,16,25,25025,250250,16,31,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	16	112	NULL	31	0	0	0	0	0	0.000366562	1	1	0.000366562	g	mi
1,1,2035,7,5,16,25,25025,250250,16,31,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	16	111	NULL	31	0	0	0	0	0	0.00141969	1	1	0.00141969	g	mi
1,1,2035,7,5,16,25,25025,250250,16,31,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	16	110	NULL	31	0	0	0	0	0	0.00253955	1	1	0.00253955	g	mi
1,1,2035,7,5,16,25,25025,250250,16,31,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	16	107	NULL	31	0	0	0	0	0	0.0111743	1	1	0.0111743	g	mi
1,1,2035,7,5,16,25,25025,250250,16,31,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	16	106	NULL	31	0	0	0	0	0	0.044257998	1	1	0.044257998	g	mi
1,1,2035,7,5,16,25,25025,250250,16,31,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	16	100	NULL	31	0	0	0	0	0	0.00286391	1	1	0.00286391	g	mi
1,1,2035,7,5,16,25,25025,250250,16,31,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	16	98	NULL	31	0	0	0	0	0	285.394989	1	1	285.394989	g	mi
1,1,2035,7,5,16,25,25025,250250,16,31,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	16	91	NULL	31	0	0	0	0	0	0.00376163	1	1	0.00376163	g	mi
1,1,2035,7,5,16,25,25025,250250,16,31,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	16	90	NULL	31	0	0	0	0	0	285.3500061	1	1	285.3500061	g	mi
1,1,2035,7,5,16,25,25025,250250,16,31,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	16	87	NULL	31	0	0	0	0	0	0.046487361	1	1	0.046487361	g	mi
1,1,2035,7,5,16,25,25025,250250,16,31,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	16	79	NULL	31	0	0	0	0	0	0.042163581	1	1	0.042163581	g	mi
1,1,2035,7,5,16,25,25025,250250,16,31,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	16	66	NULL	31	0	0	0	0	0	2.64014E-05	1	1	2.64014E-05	g	mi
1,1,2035,7,5,16,25,25025,250250,16,31,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	16	59	NULL	31	0	0	0	0	0	4.64658E-05	1	1	4.64658E-05	g	mi
1,1,2035,7,5,16,25,25025,250250,16,31,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	16	58	NULL	31	0	0	0	0	0	8.22905E-06	1	1	8.22905E-06	g	mi
1,1,2035,7,5,16,25,25025,250250,16,31,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	16	57	NULL	31	0	0	0	0	0	8.22225E-06	1	1	8.22225E-06	g	mi
1,1,2035,7,5,16,25,25025,250250,16,31,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	16	56	NULL	31	0	0	0	0	0	8.70917E-07	1	1	8.70917E-07	g	mi
1,1,2035,7,5,16,25,25025,250250,16,31,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	16	55	NULL	31	0	0	0	0	0	3.66629E-05	1	1	3.66629E-05	g	mi
1,1,2035,7,5,16,25,25025,250250,16,31,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	16	54	NULL	31	0	0	0	0	0	3.76707E-06	1	1	3.76707E-06	g	mi
1,1,2035,7,5,16,25,25025,250250,16,31,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	16	53	NULL	31	0	0	0	0	0	2.18373E-06	1	1	2.18373E-06	g	mi
1,1,2035,7,5,16,25,25025,250250,16,31,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	16	52	NULL	31	0	0	0	0	0	2.03262E-06	1	1	2.03262E-06	g	mi
1,1,2035,7,5,16,25,25025,250250,16,31,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	16	51	NULL	31	0	0	0	0	0	2.66607E-06	1	1	2.66607E-06	g	mi
1,1,2035,7,5,16,25,25025,250250,16,31,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	16	36	NULL	31	0	0	0	0	0	6.96171E-05	1	1	6.96171E-05	g	mi
1,1,2035,7,5,16,25,25025,250250,16,31,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	16	35	NULL	31	0	0	0	0	0	7.2431E-06	1	1	7.2431E-06	g	mi
1,1,2035,7,5,16,25,25025,250250,16,31,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	16	31	NULL	31	0	0	0	0	0	0.00193732	1	1	0.00193732	g	mi

1,1,2035,7,5,16,25,25025,250250,16,31,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	16	5	NULL	31	0	0	0	0	0	0.001845748	1	1	0.001845748	g	mi
1,1,2035,7,5,16,25,25025,250250,16,31,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	16	3	NULL	31	0	0	0	0	0	0.027752411	1	1	0.027752411	g	mi
1,1,2035,7,5,16,25,25025,250250,16,31,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	16	2	NULL	31	0	0	0	0	0	1.036638856	1	1	1.036638856	g	mi
1,1,2035,7,5,16,25,25025,250250,16,31,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	16	1	NULL	31	0	0	0	0	0	0.043992229	1	1	0.043992229	g	mi
1,1,2035,7,5,16,25,25025,250250,15,31,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	15	122	NULL	31	0	0	0	0	0	0.000313002	1	1	0.000313002	g	mi
1,1,2035,7,5,16,25,25025,250250,15,31,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	15	121	NULL	31	0	0	0	0	0	0.000127316	1	1	0.000127316	g	mi
1,1,2035,7,5,16,25,25025,250250,15,31,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	15	119	NULL	31	0	0	0	0	0	0	1	1	0	g	mi
1,1,2035,7,5,16,25,25025,250250,15,31,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	15	118	NULL	31	0	0	0	0	0	0.00240787	1	1	0.00240787	g	mi
1,1,2035,7,5,16,25,25025,250250,15,31,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	15	117	NULL	31	0	0	0	0	0	0.00180567	1	1	0.00180567	g	mi
1,1,2035,7,5,16,25,25025,250250,15,31,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	15	116	NULL	31	0	0	0	0	0	0.00732565	1	1	0.00732565	g	mi
1,1,2035,7,5,16,25,25025,250250,15,31,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	15	115	NULL	31	0	0	0	0	0	0.000195401	1	1	0.000195401	g	mi
1,1,2035,7,5,16,25,25025,250250,15,31,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	15	112	NULL	31	0	0	0	0	0	0.000405199	1	1	0.000405199	g	mi
1,1,2035,7,5,16,25,25025,250250,15,31,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	15	111	NULL	31	0	0	0	0	0	0.00156501	1	1	0.00156501	g	mi
1,1,2035,7,5,16,25,25025,250250,15,31,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	15	110	NULL	31	0	0	0	0	0	0.00281307	1	1	0.00281307	g	mi
1,1,2035,7,5,16,25,25025,250250,15,31,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	15	107	NULL	31	0	0	0	0	0	0.0120379	1	1	0.0120379	g	mi
1,1,2035,7,5,16,25,25025,250250,15,31,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	15	106	NULL	31	0	0	0	0	0	0.058605202	1	1	0.058605202	g	mi
1,1,2035,7,5,16,25,25025,250250,15,31,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	15	100	NULL	31	0	0	0	0	0	0.00317159	1	1	0.00317159	g	mi
1,1,2035,7,5,16,25,25025,250250,15,31,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	15	98	NULL	31	0	0	0	0	0	320.2579956	1	1	320.2579956	g	mi
1,1,2035,7,5,16,25,25025,250250,15,31,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	15	91	NULL	31	0	0	0	0	0	0.00422116	1	1	0.00422116	g	mi
1,1,2035,7,5,16,25,25025,250250,15,31,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	15	90	NULL	31	0	0	0	0	0	320.2090149	1	1	320.2090149	g	mi
1,1,2035,7,5,16,25,25025,250250,15,31,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	15	87	NULL	31	0	0	0	0	0	0.048671626	1	1	0.048671626	g	mi
1,1,2035,7,5,16,25,25025,250250,15,31,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	15	79	NULL	31	0	0	0	0	0	0.044116881	1	1	0.044116881	g	mi
1,1,2035,7,5,16,25,25025,250250,15,31,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	15	66	NULL	31	0	0	0	0	0	3.16816E-05	1	1	3.16816E-05	g	mi
1,1,2035,7,5,16,25,25025,250250,15,31,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	15	59	NULL	31	0	0	0	0	0	5.1207E-05	1	1	5.1207E-05	g	mi
1,1,2035,7,5,16,25,25025,250250,15,31,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	15	58	NULL	31	0	0	0	0	0	9.06803E-06	1	1	9.06803E-06	g	mi
1,1,2035,7,5,16,25,25025,250250,15,31,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	15	57	NULL	31	0	0	0	0	0	9.0599E-06	1	1	9.0599E-06	g	mi
1,1,2035,7,5,16,25,25025,250250,15,31,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	15	56	NULL	31	0	0	0	0	0	9.60412E-07	1	1	9.60412E-07	g	mi

1,1,2035,7,5,16,25,25025,250250,15,31,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	15	55	NULL	31	0	0	0	0	0	4.04017E-05	1	1	4.04017E-05	g	mi
1,1,2035,7,5,16,25,25025,250250,15,31,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	15	54	NULL	31	0	0	0	0	0	4.16247E-06	1	1	4.16247E-06	g	mi
1,1,2035,7,5,16,25,25025,250250,15,31,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	15	53	NULL	31	0	0	0	0	0	2.40889E-06	1	1	2.40889E-06	g	mi
1,1,2035,7,5,16,25,25025,250250,15,31,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	15	52	NULL	31	0	0	0	0	0	2.36406E-06	1	1	2.36406E-06	g	mi
1,1,2035,7,5,16,25,25025,250250,15,31,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	15	51	NULL	31	0	0	0	0	0	2.9397E-06	1	1	2.9397E-06	g	mi
1,1,2035,7,5,16,25,25025,250250,15,31,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	15	36	NULL	31	0	0	0	0	0	7.65982E-05	1	1	7.65982E-05	g	mi
1,1,2035,7,5,16,25,25025,250250,15,31,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	15	35	NULL	31	0	0	0	0	0	7.97091E-06	1	1	7.97091E-06	g	mi
1,1,2035,7,5,16,25,25025,250250,15,31,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	15	31	NULL	31	0	0	0	0	0	0.00217402	1	1	0.00217402	g	mi
1,1,2035,7,5,16,25,25025,250250,15,31,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	15	5	NULL	31	0	0	0	0	0	0.001956782	1	1	0.001956782	g	mi
1,1,2035,7,5,16,25,25025,250250,15,31,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	15	3	NULL	31	0	0	0	0	0	0.028099224	1	1	0.028099224	g	mi
1,1,2035,7,5,16,25,25025,250250,15,31,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	15	2	NULL	31	0	0	0	0	0	1.041411161	1	1	1.041411161	g	mi
1,1,2035,7,5,16,25,25025,250250,15,31,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	15	1	NULL	31	0	0	0	0	0	0.046056021	1	1	0.046056021	g	mi
1,1,2035,7,5,16,25,25025,250250,14,31,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	14	122	NULL	31	0	0	0	0	0	0.000367451	1	1	0.000367451	g	mi
1,1,2035,7,5,16,25,25025,250250,14,31,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	14	121	NULL	31	0	0	0	0	0	0.000149369	1	1	0.000149369	g	mi
1,1,2035,7,5,16,25,25025,250250,14,31,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	14	119	NULL	31	0	0	0	0	0	0	1	1	0	g	mi
1,1,2035,7,5,16,25,25025,250250,14,31,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	14	118	NULL	31	0	0	0	0	0	0.00283531	1	1	0.00283531	g	mi
1,1,2035,7,5,16,25,25025,250250,14,31,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	14	117	NULL	31	0	0	0	0	0	0.00194537	1	1	0.00194537	g	mi
1,1,2035,7,5,16,25,25025,250250,14,31,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	14	116	NULL	31	0	0	0	0	0	0.00826571	1	1	0.00826571	g	mi
1,1,2035,7,5,16,25,25025,250250,14,31,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	14	115	NULL	31	0	0	0	0	0	0.000238114	1	1	0.000238114	g	mi
1,1,2035,7,5,16,25,25025,250250,14,31,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	14	112	NULL	31	0	0	0	0	0	0.000476195	1	1	0.000476195	g	mi
1,1,2035,7,5,16,25,25025,250250,14,31,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	14	111	NULL	31	0	0	0	0	0	0.00183725	1	1	0.00183725	g	mi
1,1,2035,7,5,16,25,25025,250250,14,31,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	14	110	NULL	31	0	0	0	0	0	0.00331151	1	1	0.00331151	g	mi
1,1,2035,7,5,16,25,25025,250250,14,31,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	14	107	NULL	31	0	0	0	0	0	0.0129692	1	1	0.0129692	g	mi
1,1,2035,7,5,16,25,25025,250250,14,31,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	14	106	NULL	31	0	0	0	0	0	0.066125698	1	1	0.066125698	g	mi
1,1,2035,7,5,16,25,25025,250250,14,31,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	14	100	NULL	31	0	0	0	0	0	0.00373303	1	1	0.00373303	g	mi
1,1,2035,7,5,16,25,25025,250250,14,31,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	14	98	NULL	31	0	0	0	0	0	358.2470093	1	1	358.2470093	g	mi
1,1,2035,7,5,16,25,25025,250250,14,31,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	14	91	NULL	31	0	0	0	0	0	0.00472192	1	1	0.00472192	g	mi

1,1,2035,7,5,16,25,25025,250250,14,31,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	14	90	NULL	31	0	0	0	0	0	358.1929932	1	1	358.1929932	g	mi	
1,1,2035,7,5,16,25,25025,250250,14,31,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	14	87	NULL	31	0	0	0	0	0	0.052193224	1	1	0.052193224	g	mi	
1,1,2035,7,5,16,25,25025,250250,14,31,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	14	79	NULL	31	0	0	0	0	0	0.047306679	1	1	0.047306679	g	mi	
1,1,2035,7,5,16,25,25025,250250,14,31,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	14	66	NULL	31	0	0	0	0	0	3.9602E-05	1	1	3.9602E-05	g	mi	
1,1,2035,7,5,16,25,25025,250250,14,31,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	14	59	NULL	31	0	0	0	0	0	6.01009E-05	1	1	6.01009E-05	g	mi	
1,1,2035,7,5,16,25,25025,250250,14,31,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	14	58	NULL	31	0	0	0	0	0	1.06429E-05	1	1	1.06429E-05	g	mi	
1,1,2035,7,5,16,25,25025,250250,14,31,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	14	57	NULL	31	0	0	0	0	0	1.06345E-05	1	1	1.06345E-05	g	mi	
1,1,2035,7,5,16,25,25025,250250,14,31,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	14	56	NULL	31	0	0	0	0	0	1.12772E-06	1	1	1.12772E-06	g	mi	
1,1,2035,7,5,16,25,25025,250250,14,31,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	14	55	NULL	31	0	0	0	0	0	4.74198E-05	1	1	4.74198E-05	g	mi	
1,1,2035,7,5,16,25,25025,250250,14,31,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	14	54	NULL	31	0	0	0	0	0	4.89305E-06	1	1	4.89305E-06	g	mi	
1,1,2035,7,5,16,25,25025,250250,14,31,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	14	53	NULL	31	0	0	0	0	0	2.82903E-06	1	1	2.82903E-06	g	mi	
1,1,2035,7,5,16,25,25025,250250,14,31,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	14	52	NULL	31	0	0	0	0	0	2.86065E-06	1	1	2.86065E-06	g	mi	
1,1,2035,7,5,16,25,25025,250250,14,31,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	14	51	NULL	31	0	0	0	0	0	3.45255E-06	1	1	3.45255E-06	g	mi	
1,1,2035,7,5,16,25,25025,250250,14,31,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	14	36	NULL	31	0	0	0	0	0	8.98193E-05	1	1	8.98193E-05	g	mi	
1,1,2035,7,5,16,25,25025,250250,14,31,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	14	35	NULL	31	0	0	0	0	0	9.34913E-06	1	1	9.34913E-06	g	mi	
1,1,2035,7,5,16,25,25025,250250,14,31,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	14	31	NULL	31	0	0	0	0	0	0.00243169	1	1	0.00243169	g	mi	
1,1,2035,7,5,16,25,25025,250250,14,31,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	14	5	NULL	31	0	0	0	0	0	0.002176681	1	1	0.002176681	g	mi	
1,1,2035,7,5,16,25,25025,250250,14,31,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	14	3	NULL	31	0	0	0	0	0	0.029225569	1	1	0.029225569	g	mi	
1,1,2035,7,5,16,25,25025,250250,14,31,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	14	2	NULL	31	0	0	0	0	0	1.276393414	1	1	1.276393414	g	mi	
1,1,2035,7,5,16,25,25025,250250,14,31,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	14	1	NULL	31	0	0	0	0	0	0.049464379	1	1	0.049464379	g	mi	
1,1,2035,7,5,16,25,25025,250250,13,31,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	13	122	NULL	31	0	0	0	0	0	0.000403137	1	1	0.000403137	g	mi	
1,1,2035,7,5,16,25,25025,250250,13,31,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	13	121	NULL	31	0	0	0	0	0	0.000163564	1	1	0.000163564	g	mi	
1,1,2035,7,5,16,25,25025,250250,13,31,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	13	119	NULL	31	0	0	0	0	0	0	1	1	0	g	mi	
1,1,2035,7,5,16,25,25025,250250,13,31,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	13	118	NULL	31	0	0	0	0	0	0.00313914	1	1	0.00313914	g	mi	
1,1,2035,7,5,16,25,25025,250250,13,31,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	13	117	NULL	31	0	0	0	0	0	0.00209615	1	1	0.00209615	g	mi	
1,1,2035,7,5,16,25,25025,250250,13,31,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	13	116	NULL	31	0	0	0	0	0	0.00985679	1	1	0.00985679	g	mi	
1,1,2035,7,5,16,25,25025,250250,13,31,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	13	115	NULL	31	0	0	0	0	0	0.000290165	1	1	0.000290165	g	mi	

1,1,2035,7,5,16,25,25025,250250,13,31,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	13	112	NULL	31	0	0	0	0	0	0.000524631	1	1	0.000524631	g	mi
1,1,2035,7,5,16,25,25025,250250,13,31,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	13	111	NULL	31	0	0	0	0	0	0.00201568	1	1	0.00201568	g	mi
1,1,2035,7,5,16,25,25025,250250,13,31,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	13	110	NULL	31	0	0	0	0	0	0.00366378	1	1	0.00366378	g	mi
1,1,2035,7,5,16,25,25025,250250,13,31,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	13	107	NULL	31	0	0	0	0	0	0.0139744	1	1	0.0139744	g	mi
1,1,2035,7,5,16,25,25025,250250,13,31,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	13	106	NULL	31	0	0	0	0	0	0.0788543	1	1	0.0788543	g	mi
1,1,2035,7,5,16,25,25025,250250,13,31,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	13	100	NULL	31	0	0	0	0	0	0.00412837	1	1	0.00412837	g	mi
1,1,2035,7,5,16,25,25025,250250,13,31,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	13	98	NULL	31	0	0	0	0	0	416.8559875	1	1	416.8559875	g	mi
1,1,2035,7,5,16,25,25025,250250,13,31,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	13	91	NULL	31	0	0	0	0	0	0.005494543	1	1	0.005494543	g	mi
1,1,2035,7,5,16,25,25025,250250,13,31,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	13	90	NULL	31	0	0	0	0	0	416.7950134	1	1	416.7950134	g	mi
1,1,2035,7,5,16,25,25025,250250,13,31,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	13	87	NULL	31	0	0	0	0	0	0.057612464	1	1	0.057612464	g	mi
1,1,2035,7,5,16,25,25025,250250,13,31,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	13	79	NULL	31	0	0	0	0	0	0.05214306	1	1	0.05214306	g	mi
1,1,2035,7,5,16,25,25025,250250,13,31,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	13	66	NULL	31	0	0	0	0	0	5.28027E-05	1	1	5.28027E-05	g	mi
1,1,2035,7,5,16,25,25025,250250,13,31,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	13	59	NULL	31	0	0	0	0	0	6.58971E-05	1	1	6.58971E-05	g	mi
1,1,2035,7,5,16,25,25025,250250,13,31,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	13	58	NULL	31	0	0	0	0	0	1.16684E-05	1	1	1.16684E-05	g	mi
1,1,2035,7,5,16,25,25025,250250,13,31,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	13	57	NULL	31	0	0	0	0	0	1.16604E-05	1	1	1.16604E-05	g	mi
1,1,2035,7,5,16,25,25025,250250,13,31,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	13	56	NULL	31	0	0	0	0	0	1.23803E-06	1	1	1.23803E-06	g	mi
1,1,2035,7,5,16,25,25025,250250,13,31,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	13	55	NULL	31	0	0	0	0	0	5.19924E-05	1	1	5.19924E-05	g	mi
1,1,2035,7,5,16,25,25025,250250,13,31,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	13	54	NULL	31	0	0	0	0	0	5.3902E-06	1	1	5.3902E-06	g	mi
1,1,2035,7,5,16,25,25025,250250,13,31,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	13	53	NULL	31	0	0	0	0	0	3.10745E-06	1	1	3.10745E-06	g	mi
1,1,2035,7,5,16,25,25025,250250,13,31,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	13	52	NULL	31	0	0	0	0	0	3.42114E-06	1	1	3.42114E-06	g	mi
1,1,2035,7,5,16,25,25025,250250,13,31,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	13	51	NULL	31	0	0	0	0	0	3.79117E-06	1	1	3.79117E-06	g	mi
1,1,2035,7,5,16,25,25025,250250,13,31,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	13	36	NULL	31	0	0	0	0	0	9.82044E-05	1	1	9.82044E-05	g	mi
1,1,2035,7,5,16,25,25025,250250,13,31,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	13	35	NULL	31	0	0	0	0	0	1.02277E-05	1	1	1.02277E-05	g	mi
1,1,2035,7,5,16,25,25025,250250,13,31,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	13	31	NULL	31	0	0	0	0	0	0.00282915	1	1	0.00282915	g	mi
1,1,2035,7,5,16,25,25025,250250,13,31,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	13	5	NULL	31	0	0	0	0	0	0.002433197	1	1	0.002433197	g	mi
1,1,2035,7,5,16,25,25025,250250,13,31,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	13	3	NULL	31	0	0	0	0	0	0.030868035	1	1	0.030868035	g	mi
1,1,2035,7,5,16,25,25025,250250,13,31,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	13	2	NULL	31	0	0	0	0	0	1.405640483	1	1	1.405640483	g	mi

1,1,2035,7,5,16,25,25025,250250,13,31,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	13	1	NULL	31	0	0	0	0	0	0.054556232	1	1	0.054556232	g	mi
1,1,2035,7,5,16,25,25025,250250,12,31,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	12	122	NULL	31	0	0	0	0	0	0.000441687	1	1	0.000441687	g	mi
1,1,2035,7,5,16,25,25025,250250,12,31,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	12	121	NULL	31	0	0	0	0	0	0.000178508	1	1	0.000178508	g	mi
1,1,2035,7,5,16,25,25025,250250,12,31,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	12	119	NULL	31	0	0	0	0	0	0	1	1	0	g	mi
1,1,2035,7,5,16,25,25025,250250,12,31,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	12	118	NULL	31	0	0	0	0	0	0.00350326	1	1	0.00350326	g	mi
1,1,2035,7,5,16,25,25025,250250,12,31,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	12	117	NULL	31	0	0	0	0	0	0.0022581	1	1	0.0022581	g	mi
1,1,2035,7,5,16,25,25025,250250,12,31,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	12	116	NULL	31	0	0	0	0	0	0.0130535	1	1	0.0130535	g	mi
1,1,2035,7,5,16,25,25025,250250,12,31,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	12	115	NULL	31	0	0	0	0	0	0.00038286	1	1	0.00038286	g	mi
1,1,2035,7,5,16,25,25025,250250,12,31,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	12	112	NULL	31	0	0	0	0	0	0.000579841	1	1	0.000579841	g	mi
1,1,2035,7,5,16,25,25025,250250,12,31,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	12	111	NULL	31	0	0	0	0	0	0.00220843	1	1	0.00220843	g	mi
1,1,2035,7,5,16,25,25025,250250,12,31,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	12	110	NULL	31	0	0	0	0	0	0.0040831	1	1	0.0040831	g	mi
1,1,2035,7,5,16,25,25025,250250,12,31,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	12	107	NULL	31	0	0	0	0	0	0.0150541	1	1	0.0150541	g	mi
1,1,2035,7,5,16,25,25025,250250,12,31,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	12	106	NULL	31	0	0	0	0	0	0.104428001	1	1	0.104428001	g	mi
1,1,2035,7,5,16,25,25025,250250,12,31,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	12	100	NULL	31	0	0	0	0	0	0.00459695	1	1	0.00459695	g	mi
1,1,2035,7,5,16,25,25025,250250,12,31,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	12	98	NULL	31	0	0	0	0	0	531.2680054	1	1	531.2680054	g	mi
1,1,2035,7,5,16,25,25025,250250,12,31,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	12	91	NULL	31	0	0	0	0	0	0.007002824	1	1	0.007002824	g	mi
1,1,2035,7,5,16,25,25025,250250,12,31,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	12	90	NULL	31	0	0	0	0	0	531.1970215	1	1	531.1970215	g	mi
1,1,2035,7,5,16,25,25025,250250,12,31,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	12	87	NULL	31	0	0	0	0	0	0.068182535	1	1	0.068182535	g	mi
1,1,2035,7,5,16,25,25025,250250,12,31,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	12	79	NULL	31	0	0	0	0	0	0.061529711	1	1	0.061529711	g	mi
1,1,2035,7,5,16,25,25025,250250,12,31,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	12	66	NULL	31	0	0	0	0	0	7.9204E-05	1	1	7.9204E-05	g	mi
1,1,2035,7,5,16,25,25025,250250,12,31,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	12	59	NULL	31	0	0	0	0	0	7.21088E-05	1	1	7.21088E-05	g	mi
1,1,2035,7,5,16,25,25025,250250,12,31,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	12	58	NULL	31	0	0	0	0	0	1.2766E-05	1	1	1.2766E-05	g	mi
1,1,2035,7,5,16,25,25025,250250,12,31,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	12	57	NULL	31	0	0	0	0	0	1.27594E-05	1	1	1.27594E-05	g	mi
1,1,2035,7,5,16,25,25025,250250,12,31,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	12	56	NULL	31	0	0	0	0	0	1.35818E-06	1	1	1.35818E-06	g	mi
1,1,2035,7,5,16,25,25025,250250,12,31,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	12	55	NULL	31	0	0	0	0	0	5.68907E-05	1	1	5.68907E-05	g	mi
1,1,2035,7,5,16,25,25025,250250,12,31,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	12	54	NULL	31	0	0	0	0	0	5.95504E-06	1	1	5.95504E-06	g	mi
1,1,2035,7,5,16,25,25025,250250,12,31,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	12	53	NULL	31	0	0	0	0	0	3.41288E-06	1	1	3.41288E-06	g	mi

1,1,2035,7,5,16,25,25025,250250,12,31,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	12	52	NULL	31	0	0	0	0	0	4.38284E-06	1	1	4.38284E-06	g	mi
1,1,2035,7,5,16,25,25025,250250,12,31,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	12	51	NULL	31	0	0	0	0	0	4.16076E-06	1	1	4.16076E-06	g	mi
1,1,2035,7,5,16,25,25025,250250,12,31,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	12	36	NULL	31	0	0	0	0	0	0.000106838	1	1	0.000106838	g	mi
1,1,2035,7,5,16,25,25025,250250,12,31,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	12	35	NULL	31	0	0	0	0	0	1.11393E-05	1	1	1.11393E-05	g	mi
1,1,2035,7,5,16,25,25025,250250,12,31,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	12	31	NULL	31	0	0	0	0	0	0.00360497	1	1	0.00360497	g	mi
1,1,2035,7,5,16,25,25025,250250,12,31,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	12	5	NULL	31	0	0	0	0	0	0.002880662	1	1	0.002880662	g	mi
1,1,2035,7,5,16,25,25025,250250,12,31,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	12	3	NULL	31	0	0	0	0	0	0.034012958	1	1	0.034012958	g	mi
1,1,2035,7,5,16,25,25025,250250,12,31,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	12	2	NULL	31	0	0	0	0	0	1.507733583	1	1	1.507733583	g	mi
1,1,2035,7,5,16,25,25025,250250,12,31,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	12	1	NULL	31	0	0	0	0	0	0.064389169	1	1	0.064389169	g	mi
1,1,2035,7,5,16,25,25025,250250,11,31,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	11	122	NULL	31	0	0	0	0	0	0.000557337	1	1	0.000557337	g	mi
1,1,2035,7,5,16,25,25025,250250,11,31,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	11	121	NULL	31	0	0	0	0	0	0.00022334	1	1	0.00022334	g	mi
1,1,2035,7,5,16,25,25025,250250,11,31,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	11	119	NULL	31	0	0	0	0	0	0	1	1	0	g	mi
1,1,2035,7,5,16,25,25025,250250,11,31,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	11	118	NULL	31	0	0	0	0	0	0.0045956	1	1	0.0045956	g	mi
1,1,2035,7,5,16,25,25025,250250,11,31,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	11	117	NULL	31	0	0	0	0	0	0.0024332	1	1	0.0024332	g	mi
1,1,2035,7,5,16,25,25025,250250,11,31,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	11	116	NULL	31	0	0	0	0	0	0.022643499	1	1	0.022643499	g	mi
1,1,2035,7,5,16,25,25025,250250,11,31,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	11	115	NULL	31	0	0	0	0	0	0.000660946	1	1	0.000660946	g	mi
1,1,2035,7,5,16,25,25025,250250,11,31,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	11	112	NULL	31	0	0	0	0	0	0.000745472	1	1	0.000745472	g	mi
1,1,2035,7,5,16,25,25025,250250,11,31,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	11	111	NULL	31	0	0	0	0	0	0.00278668	1	1	0.00278668	g	mi
1,1,2035,7,5,16,25,25025,250250,11,31,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	11	110	NULL	31	0	0	0	0	0	0.00534107	1	1	0.00534107	g	mi
1,1,2035,7,5,16,25,25025,250250,11,31,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	11	107	NULL	31	0	0	0	0	0	0.0162214	1	1	0.0162214	g	mi
1,1,2035,7,5,16,25,25025,250250,11,31,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	11	106	NULL	31	0	0	0	0	0	0.181147993	1	1	0.181147993	g	mi
1,1,2035,7,5,16,25,25025,250250,11,31,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	11	100	NULL	31	0	0	0	0	0	0.00600268	1	1	0.00600268	g	mi
1,1,2035,7,5,16,25,25025,250250,11,31,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	11	98	NULL	31	0	0	0	0	0	874.5059814	1	1	874.5059814	g	mi
1,1,2035,7,5,16,25,25025,250250,11,31,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	11	91	NULL	31	0	0	0	0	0	0.011527635	1	1	0.011527635	g	mi
1,1,2035,7,5,16,25,25025,250250,11,31,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	11	90	NULL	31	0	0	0	0	0	874.401001	1	1	874.401001	g	mi
1,1,2035,7,5,16,25,25025,250250,11,31,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	11	87	NULL	31	0	0	0	0	0	0.099892974	1	1	0.099892974	g	mi
1,1,2035,7,5,16,25,25025,250250,11,31,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	11	79	NULL	31	0	0	0	0	0	0.089689761	1	1	0.089689761	g	mi

1,1,2035,7,5,16,25,25025,250250,11,31,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	11	66	NULL	31	0	0	0	0	0	0.000158408	1	1	0.000158408	g	mi
1,1,2035,7,5,16,25,25025,250250,11,31,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	11	59	NULL	31	0	0	0	0	0	9.07437E-05	1	1	9.07437E-05	g	mi
1,1,2035,7,5,16,25,25025,250250,11,31,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	11	58	NULL	31	0	0	0	0	0	1.60588E-05	1	1	1.60588E-05	g	mi
1,1,2035,7,5,16,25,25025,250250,11,31,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	11	57	NULL	31	0	0	0	0	0	1.60563E-05	1	1	1.60563E-05	g	mi
1,1,2035,7,5,16,25,25025,250250,11,31,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	11	56	NULL	31	0	0	0	0	0	1.71865E-06	1	1	1.71865E-06	g	mi
1,1,2035,7,5,16,25,25025,250250,11,31,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	11	55	NULL	31	0	0	0	0	0	7.15858E-05	1	1	7.15858E-05	g	mi
1,1,2035,7,5,16,25,25025,250250,11,31,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	11	54	NULL	31	0	0	0	0	0	7.64953E-06	1	1	7.64953E-06	g	mi
1,1,2035,7,5,16,25,25025,250250,11,31,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	11	53	NULL	31	0	0	0	0	0	4.32914E-06	1	1	4.32914E-06	g	mi
1,1,2035,7,5,16,25,25025,250250,11,31,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	11	52	NULL	31	0	0	0	0	0	7.26795E-06	1	1	7.26795E-06	g	mi
1,1,2035,7,5,16,25,25025,250250,11,31,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	11	51	NULL	31	0	0	0	0	0	5.26952E-06	1	1	5.26952E-06	g	mi
1,1,2035,7,5,16,25,25025,250250,11,31,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	11	36	NULL	31	0	0	0	0	0	0.000132738	1	1	0.000132738	g	mi
1,1,2035,7,5,16,25,25025,250250,11,31,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	11	35	NULL	31	0	0	0	0	0	1.38741E-05	1	1	1.38741E-05	g	mi
1,1,2035,7,5,16,25,25025,250250,11,31,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	11	31	NULL	31	0	0	0	0	0	0.00593245	1	1	0.00593245	g	mi
1,1,2035,7,5,16,25,25025,250250,11,31,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	11	5	NULL	31	0	0	0	0	0	0.004223058	1	1	0.004223058	g	mi
1,1,2035,7,5,16,25,25025,250250,11,31,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	11	3	NULL	31	0	0	0	0	0	0.043447737	1	1	0.043447737	g	mi
1,1,2035,7,5,16,25,25025,250250,11,31,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	11	2	NULL	31	0	0	0	0	0	1.813992858	1	1	1.813992858	g	mi
1,1,2035,7,5,16,25,25025,250250,11,31,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	11	1	NULL	31	0	0	0	0	0	0.093887791	1	1	0.093887791	g	mi
1,1,2035,7,5,16,25,25025,250250,10,21,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	10	122	NULL	21	0	0	0	0	0	0.0002061	1	1	0.0002061	g	mi
1,1,2035,7,5,16,25,25025,250250,10,21,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	10	121	NULL	21	0	0	0	0	0	8.45829E-05	1	1	8.45829E-05	g	mi
1,1,2035,7,5,16,25,25025,250250,10,21,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	10	119	NULL	21	0	0	0	0	0	0	1	1	0	g	mi
1,1,2035,7,5,16,25,25025,250250,10,21,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	10	118	NULL	21	0	0	0	0	0	0.00151627	1	1	0.00151627	g	mi
1,1,2035,7,5,16,25,25025,250250,10,21,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	10	117	NULL	21	0	0	0	0	0	0.001229	1	1	0.001229	g	mi
1,1,2035,7,5,16,25,25025,250250,10,21,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	10	116	NULL	21	0	0	0	0	0	0.00128294	1	1	0.00128294	g	mi
1,1,2035,7,5,16,25,25025,250250,10,21,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	10	115	NULL	21	0	0	0	0	0	5.83666E-05	1	1	5.83666E-05	g	mi
1,1,2035,7,5,16,25,25025,250250,10,21,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	10	112	NULL	21	0	0	0	0	0	0.00026002	1	1	0.00026002	g	mi
1,1,2035,7,5,16,25,25025,250250,10,21,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	10	111	NULL	21	0	0	0	0	0	0.0010305	1	1	0.0010305	g	mi
1,1,2035,7,5,16,25,25025,250250,10,21,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	10	110	NULL	21	0	0	0	0	0	0.00177629	1	1	0.00177629	g	mi

1,1,2035,7,5,16,25,25025,250250,10,21,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	10	107	NULL	21	0	0	0	0	0	0.00819337	1	1	0.00819337	g	mi
1,1,2035,7,5,16,25,25025,250250,10,21,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	10	106	NULL	21	0	0	0	0	0	0.0102635	1	1	0.0102635	g	mi
1,1,2035,7,5,16,25,25025,250250,10,21,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	10	100	NULL	21	0	0	0	0	0	0.00200698	1	1	0.00200698	g	mi
1,1,2035,7,5,16,25,25025,250250,10,21,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	10	98	NULL	21	0	0	0	0	0	186.2189941	1	1	186.2189941	g	mi
1,1,2035,7,5,16,25,25025,250250,10,21,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	10	91	NULL	21	0	0	0	0	0	0.002455225	1	1	0.002455225	g	mi
1,1,2035,7,5,16,25,25025,250250,10,21,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	10	90	NULL	21	0	0	0	0	0	186.1889954	1	1	186.1889954	g	mi
1,1,2035,7,5,16,25,25025,250250,10,21,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	10	87	NULL	21	0	0	0	0	0	0.053973529	1	1	0.053973529	g	mi
1,1,2035,7,5,16,25,25025,250250,10,21,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	10	79	NULL	21	0	0	0	0	0	0.049413402	1	1	0.049413402	g	mi
1,1,2035,7,5,16,25,25025,250250,10,21,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	10	66	NULL	21	0	0	0	0	0	1.59196E-05	1	1	1.59196E-05	g	mi
1,1,2035,7,5,16,25,25025,250250,10,21,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	10	59	NULL	21	0	0	0	0	0	3.38006E-05	1	1	3.38006E-05	g	mi
1,1,2035,7,5,16,25,25025,250250,10,21,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	10	58	NULL	21	0	0	0	0	0	5.98958E-06	1	1	5.98958E-06	g	mi
1,1,2035,7,5,16,25,25025,250250,10,21,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	10	57	NULL	21	0	0	0	0	0	5.98857E-06	1	1	5.98857E-06	g	mi
1,1,2035,7,5,16,25,25025,250250,10,21,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	10	56	NULL	21	0	0	0	0	0	6.30474E-07	1	1	6.30474E-07	g	mi
1,1,2035,7,5,16,25,25025,250250,10,21,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	10	55	NULL	21	0	0	0	0	0	2.66813E-05	1	1	2.66813E-05	g	mi
1,1,2035,7,5,16,25,25025,250250,10,21,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	10	54	NULL	21	0	0	0	0	0	2.68627E-06	1	1	2.68627E-06	g	mi
1,1,2035,7,5,16,25,25025,250250,10,21,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	10	53	NULL	21	0	0	0	0	0	1.5771E-06	1	1	1.5771E-06	g	mi
1,1,2035,7,5,16,25,25025,250250,10,21,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	10	52	NULL	21	0	0	0	0	0	8.70691E-07	1	1	8.70691E-07	g	mi
1,1,2035,7,5,16,25,25025,250250,10,21,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	10	51	NULL	21	0	0	0	0	0	1.93224E-06	1	1	1.93224E-06	g	mi
1,1,2035,7,5,16,25,25025,250250,10,21,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	10	36	NULL	21	0	0	0	0	0	5.12417E-05	1	1	5.12417E-05	g	mi
1,1,2035,7,5,16,25,25025,250250,10,21,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	10	35	NULL	21	0	0	0	0	0	5.32484E-06	1	1	5.32484E-06	g	mi
1,1,2035,7,5,16,25,25025,250250,10,21,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	10	31	NULL	21	0	0	0	0	0	0.00124863	1	1	0.00124863	g	mi
1,1,2035,7,5,16,25,25025,250250,10,21,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	10	5	NULL	21	0	0	0	0	0	0.001182528	1	1	0.001182528	g	mi
1,1,2035,7,5,16,25,25025,250250,10,21,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	10	3	NULL	21	0	0	0	0	0	0.027828714	1	1	0.027828714	g	mi
1,1,2035,7,5,16,25,25025,250250,10,21,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	10	2	NULL	21	0	0	0	0	0	0.870431423	1	1	0.870431423	g	mi
1,1,2035,7,5,16,25,25025,250250,10,21,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	10	1	NULL	21	0	0	0	0	0	0.05058109	1	1	0.05058109	g	mi
1,1,2035,7,5,16,25,25025,250250,9,21,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	9	122	NULL	21	0	0	0	0	0	0.000205903	1	1	0.000205903	g	mi
1,1,2035,7,5,16,25,25025,250250,9,21,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	9	121	NULL	21	0	0	0	0	0	8.45019E-05	1	1	8.45019E-05	g	mi

1,1,2035,7,5,16,25,25025,250250,9,21,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	9	119	NULL	21	0	0	0	0	0	0	1	1	0	g	mi
1,1,2035,7,5,16,25,25025,250250,9,21,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	9	118	NULL	21	0	0	0	0	0	0.00151482	1	1	0.00151482	g	mi
1,1,2035,7,5,16,25,25025,250250,9,21,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	9	117	NULL	21	0	0	0	0	0	0.001324	1	1	0.001324	g	mi
1,1,2035,7,5,16,25,25025,250250,9,21,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	9	116	NULL	21	0	0	0	0	0	0.00198081	1	1	0.00198081	g	mi
1,1,2035,7,5,16,25,25025,250250,9,21,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	9	115	NULL	21	0	0	0	0	0	5.83107E-05	1	1	5.83107E-05	g	mi
1,1,2035,7,5,16,25,25025,250250,9,21,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	9	112	NULL	21	0	0	0	0	0	0.000259771	1	1	0.000259771	g	mi
1,1,2035,7,5,16,25,25025,250250,9,21,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	9	111	NULL	21	0	0	0	0	0	0.00102951	1	1	0.00102951	g	mi
1,1,2035,7,5,16,25,25025,250250,9,21,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	9	110	NULL	21	0	0	0	0	0	0.00177459	1	1	0.00177459	g	mi
1,1,2035,7,5,16,25,25025,250250,9,21,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	9	107	NULL	21	0	0	0	0	0	0.00882671	1	1	0.00882671	g	mi
1,1,2035,7,5,16,25,25025,250250,9,21,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	9	106	NULL	21	0	0	0	0	0	0.0158465	1	1	0.0158465	g	mi
1,1,2035,7,5,16,25,25025,250250,9,21,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	9	100	NULL	21	0	0	0	0	0	0.00200506	1	1	0.00200506	g	mi
1,1,2035,7,5,16,25,25025,250250,9,21,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	9	98	NULL	21	0	0	0	0	0	190.7220001	1	1	190.7220001	g	mi
1,1,2035,7,5,16,25,25025,250250,9,21,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	9	91	NULL	21	0	0	0	0	0	0.002514616	1	1	0.002514616	g	mi
1,1,2035,7,5,16,25,25025,250250,9,21,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	9	90	NULL	21	0	0	0	0	0	190.6940002	1	1	190.6940002	g	mi
1,1,2035,7,5,16,25,25025,250250,9,21,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	9	87	NULL	21	0	0	0	0	0	0.054735187	1	1	0.054735187	g	mi
1,1,2035,7,5,16,25,25025,250250,9,21,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	9	79	NULL	21	0	0	0	0	0	0.050072011	1	1	0.050072011	g	mi
1,1,2035,7,5,16,25,25025,250250,9,21,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	9	66	NULL	21	0	0	0	0	0	1.76884E-05	1	1	1.76884E-05	g	mi
1,1,2035,7,5,16,25,25025,250250,9,21,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	9	59	NULL	21	0	0	0	0	0	3.37682E-05	1	1	3.37682E-05	g	mi
1,1,2035,7,5,16,25,25025,250250,9,21,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	9	58	NULL	21	0	0	0	0	0	5.98384E-06	1	1	5.98384E-06	g	mi
1,1,2035,7,5,16,25,25025,250250,9,21,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	9	57	NULL	21	0	0	0	0	0	5.98283E-06	1	1	5.98283E-06	g	mi
1,1,2035,7,5,16,25,25025,250250,9,21,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	9	56	NULL	21	0	0	0	0	0	6.2987E-07	1	1	6.2987E-07	g	mi
1,1,2035,7,5,16,25,25025,250250,9,21,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	9	55	NULL	21	0	0	0	0	0	2.66558E-05	1	1	2.66558E-05	g	mi
1,1,2035,7,5,16,25,25025,250250,9,21,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	9	54	NULL	21	0	0	0	0	0	2.6837E-06	1	1	2.6837E-06	g	mi
1,1,2035,7,5,16,25,25025,250250,9,21,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	9	53	NULL	21	0	0	0	0	0	1.57559E-06	1	1	1.57559E-06	g	mi
1,1,2035,7,5,16,25,25025,250250,9,21,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	9	52	NULL	21	0	0	0	0	0	8.69857E-07	1	1	8.69857E-07	g	mi
1,1,2035,7,5,16,25,25025,250250,9,21,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	9	51	NULL	21	0	0	0	0	0	1.93039E-06	1	1	1.93039E-06	g	mi
1,1,2035,7,5,16,25,25025,250250,9,21,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	9	36	NULL	21	0	0	0	0	0	5.11926E-05	1	1	5.11926E-05	g	mi

1,1,2035,7,5,16,25,25025,250250,9,21,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	9	35	NULL	21	0	0	0	0	0	5.31974E-06	1	1	5.31974E-06	g	mi
1,1,2035,7,5,16,25,25025,250250,9,21,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	9	31	NULL	21	0	0	0	0	0	0.00127884	1	1	0.00127884	g	mi
1,1,2035,7,5,16,25,25025,250250,9,21,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	9	5	NULL	21	0	0	0	0	0	0.001152559	1	1	0.001152559	g	mi
1,1,2035,7,5,16,25,25025,250250,9,21,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	9	3	NULL	21	0	0	0	0	0	0.026067443	1	1	0.026067443	g	mi
1,1,2035,7,5,16,25,25025,250250,9,21,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	9	2	NULL	21	0	0	0	0	0	0.863840938	1	1	0.863840938	g	mi
1,1,2035,7,5,16,25,25025,250250,9,21,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	9	1	NULL	21	0	0	0	0	0	0.051210113	1	1	0.051210113	g	mi
1,1,2035,7,5,16,25,25025,250250,8,21,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	8	122	NULL	21	0	0	0	0	0	0.000211539	1	1	0.000211539	g	mi
1,1,2035,7,5,16,25,25025,250250,8,21,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	8	121	NULL	21	0	0	0	0	0	8.68148E-05	1	1	8.68148E-05	g	mi
1,1,2035,7,5,16,25,25025,250250,8,21,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	8	119	NULL	21	0	0	0	0	0	0	1	1	0	g	mi
1,1,2035,7,5,16,25,25025,250250,8,21,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	8	118	NULL	21	0	0	0	0	0	0.00155628	1	1	0.00155628	g	mi
1,1,2035,7,5,16,25,25025,250250,8,21,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	8	117	NULL	21	0	0	0	0	0	0.001427	1	1	0.001427	g	mi
1,1,2035,7,5,16,25,25025,250250,8,21,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	8	116	NULL	21	0	0	0	0	0	0.00275537	1	1	0.00275537	g	mi
1,1,2035,7,5,16,25,25025,250250,8,21,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	8	115	NULL	21	0	0	0	0	0	5.99067E-05	1	1	5.99067E-05	g	mi
1,1,2035,7,5,16,25,25025,250250,8,21,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	8	112	NULL	21	0	0	0	0	0	0.000266881	1	1	0.000266881	g	mi
1,1,2035,7,5,16,25,25025,250250,8,21,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	8	111	NULL	21	0	0	0	0	0	0.00105769	1	1	0.00105769	g	mi
1,1,2035,7,5,16,25,25025,250250,8,21,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	8	110	NULL	21	0	0	0	0	0	0.00182317	1	1	0.00182317	g	mi
1,1,2035,7,5,16,25,25025,250250,8,21,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	8	107	NULL	21	0	0	0	0	0	0.00951338	1	1	0.00951338	g	mi
1,1,2035,7,5,16,25,25025,250250,8,21,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	8	106	NULL	21	0	0	0	0	0	0.022043001	1	1	0.022043001	g	mi
1,1,2035,7,5,16,25,25025,250250,8,21,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	8	100	NULL	21	0	0	0	0	0	0.00205994	1	1	0.00205994	g	mi
1,1,2035,7,5,16,25,25025,250250,8,21,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	8	98	NULL	21	0	0	0	0	0	196.9570007	1	1	196.9570007	g	mi
1,1,2035,7,5,16,25,25025,250250,8,21,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	8	91	NULL	21	0	0	0	0	0	0.002596829	1	1	0.002596829	g	mi
1,1,2035,7,5,16,25,25025,250250,8,21,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	8	90	NULL	21	0	0	0	0	0	196.9279938	1	1	196.9279938	g	mi
1,1,2035,7,5,16,25,25025,250250,8,21,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	8	87	NULL	21	0	0	0	0	0	0.056036592	1	1	0.056036592	g	mi
1,1,2035,7,5,16,25,25025,250250,8,21,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	8	79	NULL	21	0	0	0	0	0	0.051272951	1	1	0.051272951	g	mi
1,1,2035,7,5,16,25,25025,250250,8,21,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	8	66	NULL	21	0	0	0	0	0	1.98995E-05	1	1	1.98995E-05	g	mi
1,1,2035,7,5,16,25,25025,250250,8,21,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	8	59	NULL	21	0	0	0	0	0	3.46925E-05	1	1	3.46925E-05	g	mi
1,1,2035,7,5,16,25,25025,250250,8,21,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	8	58	NULL	21	0	0	0	0	0	6.14763E-06	1	1	6.14763E-06	g	mi

1,1,2035,7,5,16,25,25025,250250,8,21,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	8	57	NULL	21	0	0	0	0	0	6.1466E-06	1	1	6.1466E-06	g	mi
1,1,2035,7,5,16,25,25025,250250,8,21,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	8	56	NULL	21	0	0	0	0	0	6.4711E-07	1	1	6.4711E-07	g	mi
1,1,2035,7,5,16,25,25025,250250,8,21,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	8	55	NULL	21	0	0	0	0	0	2.73854E-05	1	1	2.73854E-05	g	mi
1,1,2035,7,5,16,25,25025,250250,8,21,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	8	54	NULL	21	0	0	0	0	0	2.75715E-06	1	1	2.75715E-06	g	mi
1,1,2035,7,5,16,25,25025,250250,8,21,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	8	53	NULL	21	0	0	0	0	0	1.61871E-06	1	1	1.61871E-06	g	mi
1,1,2035,7,5,16,25,25025,250250,8,21,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	8	52	NULL	21	0	0	0	0	0	8.93667E-07	1	1	8.93667E-07	g	mi
1,1,2035,7,5,16,25,25025,250250,8,21,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	8	51	NULL	21	0	0	0	0	0	1.98323E-06	1	1	1.98323E-06	g	mi
1,1,2035,7,5,16,25,25025,250250,8,21,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	8	36	NULL	21	0	0	0	0	0	5.25939E-05	1	1	5.25939E-05	g	mi
1,1,2035,7,5,16,25,25025,250250,8,21,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	8	35	NULL	21	0	0	0	0	0	5.46535E-06	1	1	5.46535E-06	g	mi
1,1,2035,7,5,16,25,25025,250250,8,21,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	8	31	NULL	21	0	0	0	0	0	0.00132065	1	1	0.00132065	g	mi
1,1,2035,7,5,16,25,25025,250250,8,21,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	8	5	NULL	21	0	0	0	0	0	0.001185084	1	1	0.001185084	g	mi
1,1,2035,7,5,16,25,25025,250250,8,21,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	8	3	NULL	21	0	0	0	0	0	0.025141606	1	1	0.025141606	g	mi
1,1,2035,7,5,16,25,25025,250250,8,21,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	8	2	NULL	21	0	0	0	0	0	0.909018397	1	1	0.909018397	g	mi
1,1,2035,7,5,16,25,25025,250250,8,21,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	8	1	NULL	21	0	0	0	0	0	0.052443169	1	1	0.052443169	g	mi
1,1,2035,7,5,16,25,25025,250250,7,21,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	7	122	NULL	21	0	0	0	0	0	0.000222354	1	1	0.000222354	g	mi
1,1,2035,7,5,16,25,25025,250250,7,21,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	7	121	NULL	21	0	0	0	0	0	9.12532E-05	1	1	9.12532E-05	g	mi
1,1,2035,7,5,16,25,25025,250250,7,21,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	7	119	NULL	21	0	0	0	0	0	0	1	1	0	g	mi
1,1,2035,7,5,16,25,25025,250250,7,21,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	7	118	NULL	21	0	0	0	0	0	0.00163585	1	1	0.00163585	g	mi
1,1,2035,7,5,16,25,25025,250250,7,21,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	7	117	NULL	21	0	0	0	0	0	0.001537	1	1	0.001537	g	mi
1,1,2035,7,5,16,25,25025,250250,7,21,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	7	116	NULL	21	0	0	0	0	0	0.00369192	1	1	0.00369192	g	mi
1,1,2035,7,5,16,25,25025,250250,7,21,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	7	115	NULL	21	0	0	0	0	0	6.29695E-05	1	1	6.29695E-05	g	mi
1,1,2035,7,5,16,25,25025,250250,7,21,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	7	112	NULL	21	0	0	0	0	0	0.000280526	1	1	0.000280526	g	mi
1,1,2035,7,5,16,25,25025,250250,7,21,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	7	111	NULL	21	0	0	0	0	0	0.00111177	1	1	0.00111177	g	mi
1,1,2035,7,5,16,25,25025,250250,7,21,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	7	110	NULL	21	0	0	0	0	0	0.00191638	1	1	0.00191638	g	mi
1,1,2035,7,5,16,25,25025,250250,7,21,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	7	107	NULL	21	0	0	0	0	0	0.0102467	1	1	0.0102467	g	mi
1,1,2035,7,5,16,25,25025,250250,7,21,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	7	106	NULL	21	0	0	0	0	0	0.029535299	1	1	0.029535299	g	mi
1,1,2035,7,5,16,25,25025,250250,7,21,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	7	100	NULL	21	0	0	0	0	0	0.00216526	1	1	0.00216526	g	mi

1,1,2035,7,5,16,25,25025,250250,7,21,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	7	98	NULL	21	0	0	0	0	0	205.3419952	1	1	205.3419952	g	mi
1,1,2035,7,5,16,25,25025,250250,7,21,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	7	91	NULL	21	0	0	0	0	0	0.002707364	1	1	0.002707364	g	mi
1,1,2035,7,5,16,25,25025,250250,7,21,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	7	90	NULL	21	0	0	0	0	0	205.3099976	1	1	205.3099976	g	mi
1,1,2035,7,5,16,25,25025,250250,7,21,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	7	87	NULL	21	0	0	0	0	0	0.05792151	1	1	0.05792151	g	mi
1,1,2035,7,5,16,25,25025,250250,7,21,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	7	79	NULL	21	0	0	0	0	0	0.053046279	1	1	0.053046279	g	mi
1,1,2035,7,5,16,25,25025,250250,7,21,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	7	66	NULL	21	0	0	0	0	0	2.27422E-05	1	1	2.27422E-05	g	mi
1,1,2035,7,5,16,25,25025,250250,7,21,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	7	59	NULL	21	0	0	0	0	0	3.64662E-05	1	1	3.64662E-05	g	mi
1,1,2035,7,5,16,25,25025,250250,7,21,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	7	58	NULL	21	0	0	0	0	0	6.46192E-06	1	1	6.46192E-06	g	mi
1,1,2035,7,5,16,25,25025,250250,7,21,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	7	57	NULL	21	0	0	0	0	0	6.46084E-06	1	1	6.46084E-06	g	mi
1,1,2035,7,5,16,25,25025,250250,7,21,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	7	56	NULL	21	0	0	0	0	0	6.80194E-07	1	1	6.80194E-07	g	mi
1,1,2035,7,5,16,25,25025,250250,7,21,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	7	55	NULL	21	0	0	0	0	0	2.87855E-05	1	1	2.87855E-05	g	mi
1,1,2035,7,5,16,25,25025,250250,7,21,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	7	54	NULL	21	0	0	0	0	0	2.89811E-06	1	1	2.89811E-06	g	mi
1,1,2035,7,5,16,25,25025,250250,7,21,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	7	53	NULL	21	0	0	0	0	0	1.70147E-06	1	1	1.70147E-06	g	mi
1,1,2035,7,5,16,25,25025,250250,7,21,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	7	52	NULL	21	0	0	0	0	0	9.39356E-07	1	1	9.39356E-07	g	mi
1,1,2035,7,5,16,25,25025,250250,7,21,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	7	51	NULL	21	0	0	0	0	0	2.08462E-06	1	1	2.08462E-06	g	mi
1,1,2035,7,5,16,25,25025,250250,7,21,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	7	36	NULL	21	0	0	0	0	0	5.52827E-05	1	1	5.52827E-05	g	mi
1,1,2035,7,5,16,25,25025,250250,7,21,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	7	35	NULL	21	0	0	0	0	0	5.74476E-06	1	1	5.74476E-06	g	mi
1,1,2035,7,5,16,25,25025,250250,7,21,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	7	31	NULL	21	0	0	0	0	0	0.00137686	1	1	0.00137686	g	mi
1,1,2035,7,5,16,25,25025,250250,7,21,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	7	5	NULL	21	0	0	0	0	0	0.001269359	1	1	0.001269359	g	mi
1,1,2035,7,5,16,25,25025,250250,7,21,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	7	3	NULL	21	0	0	0	0	0	0.024724988	1	1	0.024724988	g	mi
1,1,2035,7,5,16,25,25025,250250,7,21,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	7	2	NULL	21	0	0	0	0	0	0.999509454	1	1	0.999509454	g	mi
1,1,2035,7,5,16,25,25025,250250,7,21,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	7	1	NULL	21	0	0	0	0	0	0.054299731	1	1	0.054299731	g	mi
1,1,2035,7,5,16,25,25025,250250,6,21,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	6	122	NULL	21	0	0	0	0	0	0.000237083	1	1	0.000237083	g	mi
1,1,2035,7,5,16,25,25025,250250,6,21,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	6	121	NULL	21	0	0	0	0	0	9.72981E-05	1	1	9.72981E-05	g	mi
1,1,2035,7,5,16,25,25025,250250,6,21,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	6	119	NULL	21	0	0	0	0	0	0	1	1	0	g	mi
1,1,2035,7,5,16,25,25025,250250,6,21,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	6	118	NULL	21	0	0	0	0	0	0.00174421	1	1	0.00174421	g	mi
1,1,2035,7,5,16,25,25025,250250,6,21,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	6	117	NULL	21	0	0	0	0	0	0.001656	1	1	0.001656	g	mi

1,1,2035,7,5,16,25,25025,250250,6,21,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	6	116	NULL	21	0	0	0	0	0	0.00493551	1	1	0.00493551	g	mi
1,1,2035,7,5,16,25,25025,250250,6,21,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	6	115	NULL	21	0	0	0	0	0	6.71408E-05	1	1	6.71408E-05	g	mi
1,1,2035,7,5,16,25,25025,250250,6,21,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	6	112	NULL	21	0	0	0	0	0	0.000299108	1	1	0.000299108	g	mi
1,1,2035,7,5,16,25,25025,250250,6,21,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	6	111	NULL	21	0	0	0	0	0	0.00118541	1	1	0.00118541	g	mi
1,1,2035,7,5,16,25,25025,250250,6,21,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	6	110	NULL	21	0	0	0	0	0	0.00204332	1	1	0.00204332	g	mi
1,1,2035,7,5,16,25,25025,250250,6,21,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	6	107	NULL	21	0	0	0	0	0	0.0110401	1	1	0.0110401	g	mi
1,1,2035,7,5,16,25,25025,250250,6,21,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	6	106	NULL	21	0	0	0	0	0	0.039484099	1	1	0.039484099	g	mi
1,1,2035,7,5,16,25,25025,250250,6,21,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	6	100	NULL	21	0	0	0	0	0	0.00230869	1	1	0.00230869	g	mi
1,1,2035,7,5,16,25,25025,250250,6,21,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	6	98	NULL	21	0	0	0	0	0	218.348999	1	1	218.348999	g	mi
1,1,2035,7,5,16,25,25025,250250,6,21,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	6	91	NULL	21	0	0	0	0	0	0.002878862	1	1	0.002878862	g	mi
1,1,2035,7,5,16,25,25025,250250,6,21,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	6	90	NULL	21	0	0	0	0	0	218.3150024	1	1	218.3150024	g	mi
1,1,2035,7,5,16,25,25025,250250,6,21,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	6	87	NULL	21	0	0	0	0	0	0.060318481	1	1	0.060318481	g	mi
1,1,2035,7,5,16,25,25025,250250,6,21,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	6	79	NULL	21	0	0	0	0	0	0.055284761	1	1	0.055284761	g	mi
1,1,2035,7,5,16,25,25025,250250,6,21,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	6	66	NULL	21	0	0	0	0	0	2.65326E-05	1	1	2.65326E-05	g	mi
1,1,2035,7,5,16,25,25025,250250,6,21,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	6	59	NULL	21	0	0	0	0	0	3.88818E-05	1	1	3.88818E-05	g	mi
1,1,2035,7,5,16,25,25025,250250,6,21,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	6	58	NULL	21	0	0	0	0	0	6.88998E-06	1	1	6.88998E-06	g	mi
1,1,2035,7,5,16,25,25025,250250,6,21,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	6	57	NULL	21	0	0	0	0	0	6.88883E-06	1	1	6.88883E-06	g	mi
1,1,2035,7,5,16,25,25025,250250,6,21,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	6	56	NULL	21	0	0	0	0	0	7.25252E-07	1	1	7.25252E-07	g	mi
1,1,2035,7,5,16,25,25025,250250,6,21,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	6	55	NULL	21	0	0	0	0	0	3.06923E-05	1	1	3.06923E-05	g	mi
1,1,2035,7,5,16,25,25025,250250,6,21,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	6	54	NULL	21	0	0	0	0	0	3.09009E-06	1	1	3.09009E-06	g	mi
1,1,2035,7,5,16,25,25025,250250,6,21,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	6	53	NULL	21	0	0	0	0	0	1.81418E-06	1	1	1.81418E-06	g	mi
1,1,2035,7,5,16,25,25025,250250,6,21,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	6	52	NULL	21	0	0	0	0	0	1.00158E-06	1	1	1.00158E-06	g	mi
1,1,2035,7,5,16,25,25025,250250,6,21,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	6	51	NULL	21	0	0	0	0	0	2.22272E-06	1	1	2.22272E-06	g	mi
1,1,2035,7,5,16,25,25025,250250,6,21,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	6	36	NULL	21	0	0	0	0	0	5.89448E-05	1	1	5.89448E-05	g	mi
1,1,2035,7,5,16,25,25025,250250,6,21,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	6	35	NULL	21	0	0	0	0	0	6.12531E-06	1	1	6.12531E-06	g	mi
1,1,2035,7,5,16,25,25025,250250,6,21,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	6	31	NULL	21	0	0	0	0	0	0.00146407	1	1	0.00146407	g	mi
1,1,2035,7,5,16,25,25025,250250,6,21,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	6	5	NULL	21	0	0	0	0	0	0.001358291	1	1	0.001358291	g	mi

1,1,2035,7,5,16,25,25025,250250,6,21,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	6	3	NULL	21	0	0	0	0	0	0.02424317	1	1	0.02424317	g	mi
1,1,2035,7,5,16,25,25025,250250,6,21,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	6	2	NULL	21	0	0	0	0	0	1.087555289	1	1	1.087555289	g	mi
1,1,2035,7,5,16,25,25025,250250,6,21,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	6	1	NULL	21	0	0	0	0	0	0.056626018	1	1	0.056626018	g	mi
1,1,2035,7,5,16,25,25025,250250,5,21,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	5	122	NULL	21	0	0	0	0	0	0.000260023	1	1	0.000260023	g	mi
1,1,2035,7,5,16,25,25025,250250,5,21,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	5	121	NULL	21	0	0	0	0	0	0.000106712	1	1	0.000106712	g	mi
1,1,2035,7,5,16,25,25025,250250,5,21,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	5	119	NULL	21	0	0	0	0	0	0	1	1	0	g	mi
1,1,2035,7,5,16,25,25025,250250,5,21,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	5	118	NULL	21	0	0	0	0	0	0.00191298	1	1	0.00191298	g	mi
1,1,2035,7,5,16,25,25025,250250,5,21,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	5	117	NULL	21	0	0	0	0	0	0.001784	1	1	0.001784	g	mi
1,1,2035,7,5,16,25,25025,250250,5,21,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	5	116	NULL	21	0	0	0	0	0	0.00655265	1	1	0.00655265	g	mi
1,1,2035,7,5,16,25,25025,250250,5,21,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	5	115	NULL	21	0	0	0	0	0	7.36371E-05	1	1	7.36371E-05	g	mi
1,1,2035,7,5,16,25,25025,250250,5,21,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	5	112	NULL	21	0	0	0	0	0	0.000328049	1	1	0.000328049	g	mi
1,1,2035,7,5,16,25,25025,250250,5,21,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	5	111	NULL	21	0	0	0	0	0	0.00130011	1	1	0.00130011	g	mi
1,1,2035,7,5,16,25,25025,250250,5,21,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	5	110	NULL	21	0	0	0	0	0	0.00224103	1	1	0.00224103	g	mi
1,1,2035,7,5,16,25,25025,250250,5,21,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	5	107	NULL	21	0	0	0	0	0	0.0118934	1	1	0.0118934	g	mi
1,1,2035,7,5,16,25,25025,250250,5,21,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	5	106	NULL	21	0	0	0	0	0	0.052421201	1	1	0.052421201	g	mi
1,1,2035,7,5,16,25,25025,250250,5,21,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	5	100	NULL	21	0	0	0	0	0	0.00253207	1	1	0.00253207	g	mi
1,1,2035,7,5,16,25,25025,250250,5,21,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	5	98	NULL	21	0	0	0	0	0	244.5820007	1	1	244.5820007	g	mi
1,1,2035,7,5,16,25,25025,250250,5,21,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	5	91	NULL	21	0	0	0	0	0	0.003224768	1	1	0.003224768	g	mi
1,1,2035,7,5,16,25,25025,250250,5,21,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	5	90	NULL	21	0	0	0	0	0	244.5469971	1	1	244.5469971	g	mi
1,1,2035,7,5,16,25,25025,250250,5,21,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	5	87	NULL	21	0	0	0	0	0	0.063184656	1	1	0.063184656	g	mi
1,1,2035,7,5,16,25,25025,250250,5,21,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	5	79	NULL	21	0	0	0	0	0	0.057889339	1	1	0.057889339	g	mi
1,1,2035,7,5,16,25,25025,250250,5,21,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	5	66	NULL	21	0	0	0	0	0	3.18391E-05	1	1	3.18391E-05	g	mi
1,1,2035,7,5,16,25,25025,250250,5,21,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	5	59	NULL	21	0	0	0	0	0	4.26439E-05	1	1	4.26439E-05	g	mi
1,1,2035,7,5,16,25,25025,250250,5,21,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	5	58	NULL	21	0	0	0	0	0	7.55663E-06	1	1	7.55663E-06	g	mi
1,1,2035,7,5,16,25,25025,250250,5,21,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	5	57	NULL	21	0	0	0	0	0	7.55536E-06	1	1	7.55536E-06	g	mi
1,1,2035,7,5,16,25,25025,250250,5,21,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	5	56	NULL	21	0	0	0	0	0	7.95425E-07	1	1	7.95425E-07	g	mi
1,1,2035,7,5,16,25,25025,250250,5,21,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	5	55	NULL	21	0	0	0	0	0	3.3662E-05	1	1	3.3662E-05	g	mi

1,1,2035,7,5,16,25,25025,250250,5,21,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	5	54	NULL	21	0	0	0	0	0	3.38908E-06	1	1	3.38908E-06	g	mi
1,1,2035,7,5,16,25,25025,250250,5,21,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	5	53	NULL	21	0	0	0	0	0	1.98971E-06	1	1	1.98971E-06	g	mi
1,1,2035,7,5,16,25,25025,250250,5,21,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	5	52	NULL	21	0	0	0	0	0	1.09849E-06	1	1	1.09849E-06	g	mi
1,1,2035,7,5,16,25,25025,250250,5,21,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	5	51	NULL	21	0	0	0	0	0	2.43778E-06	1	1	2.43778E-06	g	mi
1,1,2035,7,5,16,25,25025,250250,5,21,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	5	36	NULL	21	0	0	0	0	0	6.46481E-05	1	1	6.46481E-05	g	mi
1,1,2035,7,5,16,25,25025,250250,5,21,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	5	35	NULL	21	0	0	0	0	0	6.71798E-06	1	1	6.71798E-06	g	mi
1,1,2035,7,5,16,25,25025,250250,5,21,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	5	31	NULL	21	0	0	0	0	0	0.00163999	1	1	0.00163999	g	mi
1,1,2035,7,5,16,25,25025,250250,5,21,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	5	5	NULL	21	0	0	0	0	0	0.001383796	1	1	0.001383796	g	mi
1,1,2035,7,5,16,25,25025,250250,5,21,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	5	3	NULL	21	0	0	0	0	0	0.024045762	1	1	0.024045762	g	mi
1,1,2035,7,5,16,25,25025,250250,5,21,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	5	2	NULL	21	0	0	0	0	0	1.080061316	1	1	1.080061316	g	mi
1,1,2035,7,5,16,25,25025,250250,5,21,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	5	1	NULL	21	0	0	0	0	0	0.05925579	1	1	0.05925579	g	mi
1,1,2035,7,5,16,25,25025,250250,4,21,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	4	122	NULL	21	0	0	0	0	0	0.000307774	1	1	0.000307774	g	mi
1,1,2035,7,5,16,25,25025,250250,4,21,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	4	121	NULL	21	0	0	0	0	0	0.000126309	1	1	0.000126309	g	mi
1,1,2035,7,5,16,25,25025,250250,4,21,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	4	119	NULL	21	0	0	0	0	0	0	1	1	0	g	mi
1,1,2035,7,5,16,25,25025,250250,4,21,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	4	118	NULL	21	0	0	0	0	0	0.00226428	1	1	0.00226428	g	mi
1,1,2035,7,5,16,25,25025,250250,4,21,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	4	117	NULL	21	0	0	0	0	0	0.001922	1	1	0.001922	g	mi
1,1,2035,7,5,16,25,25025,250250,4,21,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	4	116	NULL	21	0	0	0	0	0	0.00745542	1	1	0.00745542	g	mi
1,1,2035,7,5,16,25,25025,250250,4,21,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	4	115	NULL	21	0	0	0	0	0	8.716E-05	1	1	8.716E-05	g	mi
1,1,2035,7,5,16,25,25025,250250,4,21,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	4	112	NULL	21	0	0	0	0	0	0.000388293	1	1	0.000388293	g	mi
1,1,2035,7,5,16,25,25025,250250,4,21,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	4	111	NULL	21	0	0	0	0	0	0.00153887	1	1	0.00153887	g	mi
1,1,2035,7,5,16,25,25025,250250,4,21,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	4	110	NULL	21	0	0	0	0	0	0.00265258	1	1	0.00265258	g	mi
1,1,2035,7,5,16,25,25025,250250,4,21,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	4	107	NULL	21	0	0	0	0	0	0.0128134	1	1	0.0128134	g	mi
1,1,2035,7,5,16,25,25025,250250,4,21,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	4	106	NULL	21	0	0	0	0	0	0.059643298	1	1	0.059643298	g	mi
1,1,2035,7,5,16,25,25025,250250,4,21,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	4	100	NULL	21	0	0	0	0	0	0.00299707	1	1	0.00299707	g	mi
1,1,2035,7,5,16,25,25025,250250,4,21,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	4	98	NULL	21	0	0	0	0	0	276.2539978	1	1	276.2539978	g	mi
1,1,2035,7,5,16,25,25025,250250,4,21,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	4	91	NULL	21	0	0	0	0	0	0.003642366	1	1	0.003642366	g	mi
1,1,2035,7,5,16,25,25025,250250,4,21,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	4	90	NULL	21	0	0	0	0	0	276.2149963	1	1	276.2149963	g	mi

1,1,2035,7,5,16,25,25025,250250,4,21,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	4	87	NULL	21	0	0	0	0	0	0.068305112	1	1	0.068305112	g	mi
1,1,2035,7,5,16,25,25025,250250,4,21,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	4	79	NULL	21	0	0	0	0	0	0.06268438	1	1	0.06268438	g	mi
1,1,2035,7,5,16,25,25025,250250,4,21,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	4	66	NULL	21	0	0	0	0	0	3.97989E-05	1	1	3.97989E-05	g	mi
1,1,2035,7,5,16,25,25025,250250,4,21,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	4	59	NULL	21	0	0	0	0	0	5.04751E-05	1	1	5.04751E-05	g	mi
1,1,2035,7,5,16,25,25025,250250,4,21,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	4	58	NULL	21	0	0	0	0	0	8.94436E-06	1	1	8.94436E-06	g	mi
1,1,2035,7,5,16,25,25025,250250,4,21,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	4	57	NULL	21	0	0	0	0	0	8.94286E-06	1	1	8.94286E-06	g	mi
1,1,2035,7,5,16,25,25025,250250,4,21,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	4	56	NULL	21	0	0	0	0	0	9.415E-07	1	1	9.415E-07	g	mi
1,1,2035,7,5,16,25,25025,250250,4,21,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	4	55	NULL	21	0	0	0	0	0	3.98438E-05	1	1	3.98438E-05	g	mi
1,1,2035,7,5,16,25,25025,250250,4,21,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	4	54	NULL	21	0	0	0	0	0	4.01146E-06	1	1	4.01146E-06	g	mi
1,1,2035,7,5,16,25,25025,250250,4,21,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	4	53	NULL	21	0	0	0	0	0	2.35511E-06	1	1	2.35511E-06	g	mi
1,1,2035,7,5,16,25,25025,250250,4,21,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	4	52	NULL	21	0	0	0	0	0	1.30022E-06	1	1	1.30022E-06	g	mi
1,1,2035,7,5,16,25,25025,250250,4,21,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	4	51	NULL	21	0	0	0	0	0	2.88546E-06	1	1	2.88546E-06	g	mi
1,1,2035,7,5,16,25,25025,250250,4,21,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	4	36	NULL	21	0	0	0	0	0	7.65204E-05	1	1	7.65204E-05	g	mi
1,1,2035,7,5,16,25,25025,250250,4,21,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	4	35	NULL	21	0	0	0	0	0	7.95169E-06	1	1	7.95169E-06	g	mi
1,1,2035,7,5,16,25,25025,250250,4,21,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	4	31	NULL	21	0	0	0	0	0	0.00185236	1	1	0.00185236	g	mi
1,1,2035,7,5,16,25,25025,250250,4,21,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	4	5	NULL	21	0	0	0	0	0	0.001579481	1	1	0.001579481	g	mi
1,1,2035,7,5,16,25,25025,250250,4,21,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	4	3	NULL	21	0	0	0	0	0	0.025783231	1	1	0.025783231	g	mi
1,1,2035,7,5,16,25,25025,250250,4,21,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	4	2	NULL	21	0	0	0	0	0	1.393504143	1	1	1.393504143	g	mi
1,1,2035,7,5,16,25,25025,250250,4,21,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	4	1	NULL	21	0	0	0	0	0	0.064244151	1	1	0.064244151	g	mi
1,1,2035,7,5,16,25,25025,250250,3,21,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	3	122	NULL	21	0	0	0	0	0	0.000357514	1	1	0.000357514	g	mi
1,1,2035,7,5,16,25,25025,250250,3,21,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	3	121	NULL	21	0	0	0	0	0	0.000146723	1	1	0.000146723	g	mi
1,1,2035,7,5,16,25,25025,250250,3,21,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	3	119	NULL	21	0	0	0	0	0	0	1	1	0	g	mi
1,1,2035,7,5,16,25,25025,250250,3,21,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	3	118	NULL	21	0	0	0	0	0	0.00263022	1	1	0.00263022	g	mi
1,1,2035,7,5,16,25,25025,250250,3,21,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	3	117	NULL	21	0	0	0	0	0	0.002071	1	1	0.002071	g	mi
1,1,2035,7,5,16,25,25025,250250,3,21,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	3	116	NULL	21	0	0	0	0	0	0.00888721	1	1	0.00888721	g	mi
1,1,2035,7,5,16,25,25025,250250,3,21,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	3	115	NULL	21	0	0	0	0	0	0.000101246	1	1	0.000101246	g	mi
1,1,2035,7,5,16,25,25025,250250,3,21,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	3	112	NULL	21	0	0	0	0	0	0.000451046	1	1	0.000451046	g	mi

1,1,2035,7,5,16,25,25025,250250,3,21,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	3	111	NULL	21	0	0	0	0	0	0.00178757	1	1	0.00178757	g	mi
1,1,2035,7,5,16,25,25025,250250,3,21,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	3	110	NULL	21	0	0	0	0	0	0.00308127	1	1	0.00308127	g	mi
1,1,2035,7,5,16,25,25025,250250,3,21,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	3	107	NULL	21	0	0	0	0	0	0.0138067	1	1	0.0138067	g	mi
1,1,2035,7,5,16,25,25025,250250,3,21,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	3	106	NULL	21	0	0	0	0	0	0.071097702	1	1	0.071097702	g	mi
1,1,2035,7,5,16,25,25025,250250,3,21,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	3	100	NULL	21	0	0	0	0	0	0.00348144	1	1	0.00348144	g	mi
1,1,2035,7,5,16,25,25025,250250,3,21,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	3	98	NULL	21	0	0	0	0	0	323.8619995	1	1	323.8619995	g	mi
1,1,2035,7,5,16,25,25025,250250,3,21,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	3	91	NULL	21	0	0	0	0	0	0.004270115	1	1	0.004270115	g	mi
1,1,2035,7,5,16,25,25025,250250,3,21,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	3	90	NULL	21	0	0	0	0	0	323.8200073	1	1	323.8200073	g	mi
1,1,2035,7,5,16,25,25025,250250,3,21,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	3	87	NULL	21	0	0	0	0	0	0.07581076	1	1	0.07581076	g	mi
1,1,2035,7,5,16,25,25025,250250,3,21,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	3	79	NULL	21	0	0	0	0	0	0.069564022	1	1	0.069564022	g	mi
1,1,2035,7,5,16,25,25025,250250,3,21,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	3	66	NULL	21	0	0	0	0	0	5.30652E-05	1	1	5.30652E-05	g	mi
1,1,2035,7,5,16,25,25025,250250,3,21,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	3	59	NULL	21	0	0	0	0	0	5.86326E-05	1	1	5.86326E-05	g	mi
1,1,2035,7,5,16,25,25025,250250,3,21,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	3	58	NULL	21	0	0	0	0	0	1.03899E-05	1	1	1.03899E-05	g	mi
1,1,2035,7,5,16,25,25025,250250,3,21,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	3	57	NULL	21	0	0	0	0	0	1.03881E-05	1	1	1.03881E-05	g	mi
1,1,2035,7,5,16,25,25025,250250,3,21,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	3	56	NULL	21	0	0	0	0	0	1.09366E-06	1	1	1.09366E-06	g	mi
1,1,2035,7,5,16,25,25025,250250,3,21,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	3	55	NULL	21	0	0	0	0	0	4.62831E-05	1	1	4.62831E-05	g	mi
1,1,2035,7,5,16,25,25025,250250,3,21,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	3	54	NULL	21	0	0	0	0	0	4.65977E-06	1	1	4.65977E-06	g	mi
1,1,2035,7,5,16,25,25025,250250,3,21,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	3	53	NULL	21	0	0	0	0	0	2.73573E-06	1	1	2.73573E-06	g	mi
1,1,2035,7,5,16,25,25025,250250,3,21,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	3	52	NULL	21	0	0	0	0	0	1.51035E-06	1	1	1.51035E-06	g	mi
1,1,2035,7,5,16,25,25025,250250,3,21,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	3	51	NULL	21	0	0	0	0	0	3.35179E-06	1	1	3.35179E-06	g	mi
1,1,2035,7,5,16,25,25025,250250,3,21,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	3	36	NULL	21	0	0	0	0	0	8.88871E-05	1	1	8.88871E-05	g	mi
1,1,2035,7,5,16,25,25025,250250,3,21,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	3	35	NULL	21	0	0	0	0	0	9.23679E-06	1	1	9.23679E-06	g	mi
1,1,2035,7,5,16,25,25025,250250,3,21,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	3	31	NULL	21	0	0	0	0	0	0.00217161	1	1	0.00217161	g	mi
1,1,2035,7,5,16,25,25025,250250,3,21,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	3	5	NULL	21	0	0	0	0	0	0.001698654	1	1	0.001698654	g	mi
1,1,2035,7,5,16,25,25025,250250,3,21,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	3	3	NULL	21	0	0	0	0	0	0.026550163	1	1	0.026550163	g	mi
1,1,2035,7,5,16,25,25025,250250,3,21,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	3	2	NULL	21	0	0	0	0	0	1.570075989	1	1	1.570075989	g	mi
1,1,2035,7,5,16,25,25025,250250,3,21,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	3	1	NULL	21	0	0	0	0	0	0.071241401	1	1	0.071241401	g	mi

1,1,2035,7,5,16,25,25025,250250,2,21,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	2	122	NULL	21	0	0	0	0	0	0.000439205	1	1	0.000439205	g	mi
1,1,2035,7,5,16,25,25025,250250,2,21,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	2	121	NULL	21	0	0	0	0	0	0.000180248	1	1	0.000180248	g	mi
1,1,2035,7,5,16,25,25025,250250,2,21,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	2	119	NULL	21	0	0	0	0	0	0	1	1	0	g	mi
1,1,2035,7,5,16,25,25025,250250,2,21,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	2	118	NULL	21	0	0	0	0	0	0.00323121	1	1	0.00323121	g	mi
1,1,2035,7,5,16,25,25025,250250,2,21,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	2	117	NULL	21	0	0	0	0	0	0.002231	1	1	0.002231	g	mi
1,1,2035,7,5,16,25,25025,250250,2,21,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	2	116	NULL	21	0	0	0	0	0	0.0117074	1	1	0.0117074	g	mi
1,1,2035,7,5,16,25,25025,250250,2,21,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	2	115	NULL	21	0	0	0	0	0	0.000124381	1	1	0.000124381	g	mi
1,1,2035,7,5,16,25,25025,250250,2,21,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	2	112	NULL	21	0	0	0	0	0	0.000554109	1	1	0.000554109	g	mi
1,1,2035,7,5,16,25,25025,250250,2,21,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	2	111	NULL	21	0	0	0	0	0	0.00219602	1	1	0.00219602	g	mi
1,1,2035,7,5,16,25,25025,250250,2,21,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	2	110	NULL	21	0	0	0	0	0	0.00378532	1	1	0.00378532	g	mi
1,1,2035,7,5,16,25,25025,250250,2,21,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	2	107	NULL	21	0	0	0	0	0	0.0148734	1	1	0.0148734	g	mi
1,1,2035,7,5,16,25,25025,250250,2,21,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	2	106	NULL	21	0	0	0	0	0	0.093659602	1	1	0.093659602	g	mi
1,1,2035,7,5,16,25,25025,250250,2,21,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	2	100	NULL	21	0	0	0	0	0	0.00427693	1	1	0.00427693	g	mi
1,1,2035,7,5,16,25,25025,250250,2,21,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	2	98	NULL	21	0	0	0	0	0	415.9899902	1	1	415.9899902	g	mi
1,1,2035,7,5,16,25,25025,250250,2,21,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	2	91	NULL	21	0	0	0	0	0	0.005484951	1	1	0.005484951	g	mi
1,1,2035,7,5,16,25,25025,250250,2,21,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	2	90	NULL	21	0	0	0	0	0	415.9460144	1	1	415.9460144	g	mi
1,1,2035,7,5,16,25,25025,250250,2,21,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	2	87	NULL	21	0	0	0	0	0	0.090209045	1	1	0.090209045	g	mi
1,1,2035,7,5,16,25,25025,250250,2,21,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	2	79	NULL	21	0	0	0	0	0	0.082659893	1	1	0.082659893	g	mi
1,1,2035,7,5,16,25,25025,250250,2,21,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	2	66	NULL	21	0	0	0	0	0	7.95978E-05	1	1	7.95978E-05	g	mi
1,1,2035,7,5,16,25,25025,250250,2,21,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	2	59	NULL	21	0	0	0	0	0	7.20299E-05	1	1	7.20299E-05	g	mi
1,1,2035,7,5,16,25,25025,250250,2,21,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	2	58	NULL	21	0	0	0	0	0	1.27639E-05	1	1	1.27639E-05	g	mi
1,1,2035,7,5,16,25,25025,250250,2,21,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	2	57	NULL	21	0	0	0	0	0	1.27618E-05	1	1	1.27618E-05	g	mi
1,1,2035,7,5,16,25,25025,250250,2,21,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	2	56	NULL	21	0	0	0	0	0	1.34355E-06	1	1	1.34355E-06	g	mi
1,1,2035,7,5,16,25,25025,250250,2,21,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	2	55	NULL	21	0	0	0	0	0	5.68586E-05	1	1	5.68586E-05	g	mi
1,1,2035,7,5,16,25,25025,250250,2,21,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	2	54	NULL	21	0	0	0	0	0	5.7245E-06	1	1	5.7245E-06	g	mi
1,1,2035,7,5,16,25,25025,250250,2,21,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	2	53	NULL	21	0	0	0	0	0	3.36083E-06	1	1	3.36083E-06	g	mi
1,1,2035,7,5,16,25,25025,250250,2,21,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	2	52	NULL	21	0	0	0	0	0	1.85546E-06	1	1	1.85546E-06	g	mi

1,1,2035,7,5,16,25,25025,250250,2,21,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	2	51	NULL	21	0	0	0	0	0	4.11766E-06	1	1	4.11766E-06	g	mi
1,1,2035,7,5,16,25,25025,250250,2,21,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	2	36	NULL	21	0	0	0	0	0	0.000109197	1	1	0.000109197	g	mi
1,1,2035,7,5,16,25,25025,250250,2,21,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	2	35	NULL	21	0	0	0	0	0	1.13474E-05	1	1	1.13474E-05	g	mi
1,1,2035,7,5,16,25,25025,250250,2,21,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	2	31	NULL	21	0	0	0	0	0	0.00278942	1	1	0.00278942	g	mi
1,1,2035,7,5,16,25,25025,250250,2,21,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	2	5	NULL	21	0	0	0	0	0	0.00181363	1	1	0.00181363	g	mi
1,1,2035,7,5,16,25,25025,250250,2,21,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	2	3	NULL	21	0	0	0	0	0	0.026814973	1	1	0.026814973	g	mi
1,1,2035,7,5,16,25,25025,250250,2,21,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	2	2	NULL	21	0	0	0	0	0	1.717092395	1	1	1.717092395	g	mi
1,1,2035,7,5,16,25,25025,250250,2,21,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	2	1	NULL	21	0	0	0	0	0	0.084450796	1	1	0.084450796	g	mi
1,1,2035,7,5,16,25,25025,250250,1,21,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	1	122	NULL	21	0	0	0	0	0	0.000684276	1	1	0.000684276	g	mi
1,1,2035,7,5,16,25,25025,250250,1,21,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	1	121	NULL	21	0	0	0	0	0	0.000280825	1	1	0.000280825	g	mi
1,1,2035,7,5,16,25,25025,250250,1,21,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	1	119	NULL	21	0	0	0	0	0	0	1	1	0	g	mi
1,1,2035,7,5,16,25,25025,250250,1,21,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	1	118	NULL	21	0	0	0	0	0	0.0050342	1	1	0.0050342	g	mi
1,1,2035,7,5,16,25,25025,250250,1,21,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	1	117	NULL	21	0	0	0	0	0	0.002404	1	1	0.002404	g	mi
1,1,2035,7,5,16,25,25025,250250,1,21,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	1	116	NULL	21	0	0	0	0	0	0.0201681	1	1	0.0201681	g	mi
1,1,2035,7,5,16,25,25025,250250,1,21,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	1	115	NULL	21	0	0	0	0	0	0.000193784	1	1	0.000193784	g	mi
1,1,2035,7,5,16,25,25025,250250,1,21,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	1	112	NULL	21	0	0	0	0	0	0.000863295	1	1	0.000863295	g	mi
1,1,2035,7,5,16,25,25025,250250,1,21,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	1	111	NULL	21	0	0	0	0	0	0.00342137	1	1	0.00342137	g	mi
1,1,2035,7,5,16,25,25025,250250,1,21,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	1	110	NULL	21	0	0	0	0	0	0.00589749	1	1	0.00589749	g	mi
1,1,2035,7,5,16,25,25025,250250,1,21,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	1	107	NULL	21	0	0	0	0	0	0.0160267	1	1	0.0160267	g	mi
1,1,2035,7,5,16,25,25025,250250,1,21,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	1	106	NULL	21	0	0	0	0	0	0.161345005	1	1	0.161345005	g	mi
1,1,2035,7,5,16,25,25025,250250,1,21,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	1	100	NULL	21	0	0	0	0	0	0.0066634	1	1	0.0066634	g	mi
1,1,2035,7,5,16,25,25025,250250,1,21,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	1	98	NULL	21	0	0	0	0	0	692.3759766	1	1	692.3759766	g	mi
1,1,2035,7,5,16,25,25025,250250,1,21,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	1	91	NULL	21	0	0	0	0	0	0.00912944	1	1	0.00912944	g	mi
1,1,2035,7,5,16,25,25025,250250,1,21,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	1	90	NULL	21	0	0	0	0	0	692.3220215	1	1	692.3220215	g	mi
1,1,2035,7,5,16,25,25025,250250,1,21,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	1	87	NULL	21	0	0	0	0	0	0.133404016	1	1	0.133404016	g	mi
1,1,2035,7,5,16,25,25025,250250,1,21,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	1	79	NULL	21	0	0	0	0	0	0.121947795	1	1	0.121947795	g	mi
1,1,2035,7,5,16,25,25025,250250,1,21,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	1	66	NULL	21	0	0	0	0	0	0.000159196	1	1	0.000159196	g	mi

1,1,2035,7,5,16,25,25025,250250,1,21,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	1	59	NULL	21	0	0	0	0	0	0.000112222	1	1	0.000112222	g	mi
1,1,2035,7,5,16,25,25025,250250,1,21,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	1	58	NULL	21	0	0	0	0	0	1.98861E-05	1	1	1.98861E-05	g	mi
1,1,2035,7,5,16,25,25025,250250,1,21,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	1	57	NULL	21	0	0	0	0	0	1.98827E-05	1	1	1.98827E-05	g	mi
1,1,2035,7,5,16,25,25025,250250,1,21,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	1	56	NULL	21	0	0	0	0	0	2.09324E-06	1	1	2.09324E-06	g	mi
1,1,2035,7,5,16,25,25025,250250,1,21,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	1	55	NULL	21	0	0	0	0	0	8.8585E-05	1	1	8.8585E-05	g	mi
1,1,2035,7,5,16,25,25025,250250,1,21,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	1	54	NULL	21	0	0	0	0	0	8.91871E-06	1	1	8.91871E-06	g	mi
1,1,2035,7,5,16,25,25025,250250,1,21,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	1	53	NULL	21	0	0	0	0	0	5.23614E-06	1	1	5.23614E-06	g	mi
1,1,2035,7,5,16,25,25025,250250,1,21,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	1	52	NULL	21	0	0	0	0	0	2.89079E-06	1	1	2.89079E-06	g	mi
1,1,2035,7,5,16,25,25025,250250,1,21,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	1	51	NULL	21	0	0	0	0	0	6.41526E-06	1	1	6.41526E-06	g	mi
1,1,2035,7,5,16,25,25025,250250,1,21,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	1	36	NULL	21	0	0	0	0	0	0.000170128	1	1	0.000170128	g	mi
1,1,2035,7,5,16,25,25025,250250,1,21,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	1	35	NULL	21	0	0	0	0	0	1.76791E-05	1	1	1.76791E-05	g	mi
1,1,2035,7,5,16,25,25025,250250,1,21,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	1	31	NULL	21	0	0	0	0	0	0.00464287	1	1	0.00464287	g	mi
1,1,2035,7,5,16,25,25025,250250,1,21,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	1	5	NULL	21	0	0	0	0	0	0.002158558	1	1	0.002158558	g	mi
1,1,2035,7,5,16,25,25025,250250,1,21,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	1	3	NULL	21	0	0	0	0	0	0.027609205	1	1	0.027609205	g	mi
1,1,2035,7,5,16,25,25025,250250,1,21,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	1	2	NULL	21	0	0	0	0	0	2.158131838	1	1	2.158131838	g	mi
1,1,2035,7,5,16,25,25025,250250,1,21,0,0,0,0,0,00	1	1	2035	7	5	16	25	25025	250250	1	1	NULL	21	0	0	0	0	0	0.124079295	1	1	0.124079295	g	mi

Source: KBE and Massport, 2019.

Fuel Storage and Handling

As in previous years, VOC emissions from fuel storage and handling were calculated using methods based on EPA's AP-42[1] document. Calculations account for evaporative emissions from breathing losses, working losses, and spillage from aboveground storage tanks, underground storage tanks, and aircraft refueling. In 2003, additional information became available on the fire training fuel, Tek-Flame®. Emissions of VOCs from this fuel were estimated by AEDT. **Table I-12** presents Logan Airport's fuel throughput by category.

Stationary Sources

Stationary sources include the Central Heating and Cooling Plant, emergency generators, snow melters, space heaters, and boilers. Emission factors from EPA's AP-42 or NO_x Reasonably Available Control Technology (RACT) compliance testing were combined with the actual 2017 fuel throughput of the stationary sources to obtain emissions of VOCs, NO_X, CO, and $PM_{10}/PM_{2.5}$.

Title V of the 1990 Clean Air Act (CAA) Amendments requires facilities with air emissions to document their emissions and obtain a single permit combining all sources. The permitting program ensures that all emission sources are accounted for, the proper permits have been received, and permit conditions are being followed. A Title V Air Operating Permit covers all of the stationary sources at Logan Airport including boilers, emergency generators, snow melters, fire training, cooling towers, paint booths, deicing facilities, and storage tanks. **Table I-13** presents Logan Airport's stationary source fuel throughput by fuel category.

1 Compilation of Air Pollutant Emission Factors, AP-42, Office of Air Quality Planning and Standards, EPA, Fifth Edition, 1995.

Table I-12 Fuel Throughput by Fuel Category (gallons)

Fuel Category	1999	2000	2001	2002	2003	2004	2005	2006	2007
Jet Fuel	354,095,516	441,901,932	416,748,819	358,190,362	319,439,910	373,996,141	368,645,392	364,450,864	367,585,187
Fire Training Fuel[1]	N/A	N/A	N/A	N/A	13,719	12,227	8,105	5,000	8,631
Aviation Gas	99,726	90,922	60,691	35,111	32,515	34,717	52,487	35,098	29,067
Auto Gas	7,200,000	7,569,206	6,181,472	5,754,740	5,436,322	5,803,442	5,903,424	6,028,931	6,022,237
Diesel	768,106	839,751	1,239,904	1,067,847	1,030,185	1,078,665	1,567,688	1,164,493	1,141,335
Heating Oil No.2	480,733	494,500	582,283	340,492	370,903	381,852	367,899	259,768	423,181
Heating Oil No.62	1,600,893	1,555,527	1,641,693	1,079,283	1,122,975	2,940,752	3,098,126	1,396,529	1,073,260

Fuel Category	2008	2009	2010	2011	2012	2013	2014	2015	2016
Jet Fuel	345,631,788	327,358,619	335,693,997	340,421,373	343,731,127	349,397,940	370,222,342	374,985,216	456,003,328
Fire Training Fuel[1]	5,971	3,510	800	3,810	2,587	5,400	3,753	7,619	6,153
Aviation Gas	25,037	18,238	15,268	14,064	12,306	14,422	12,514	10,225	10,654
Auto Gas	5,693,178	5,736,724	5,696,505	5,487,952	6,694,626	6,800,936	7,007,591	7,432,165	7,794,957
Diesel	1,071,707	1,121,241	1,168,761	1,099,720	878,499	1,094,714	1,178,805	1,473,720	1,233,200
Heating Oil No.2	303,143	409,049	319,727	384,906	210,794	289,665	289,956	294,704	520,977
Heating Oil No.6[2]	16,385	368,690	9,010	11,285	6,786	17,721	77,146	0	0

Table I-12 Fuel Throughput by Fuel Category (gallons) (Continued)

Fuel Category	2017
Jet Fuel	484,310,931
Fire Training Fuel[1]	5,211
Aviation Gas	11,075
Auto Gas	7,737,865
Diesel	1,272,828
Heating Oil No.2	213,279
Heating Oil No.6[2]	0

Source: Massport, 2019.
N/A Not available.
1 Fire Training Fuel used in 1999-2002 was Jet A Fuel while in 2003 through 2014 it was Tek-Flame®. 2012 includes 100 gallons of AvGas, 2013 includes 400 gallons of AvGas, 2014 includes 338 gallons of AvGas, 2015 includes 742 gallons of AvGas, 2016 includes 494 gallons of AvGas, and 2017 includes 1,241 gallons of AvGas.
2 Effective November 2014, Massport no longer uses No. 6 heating oil at the Central Heating and Cooling Plant and was replaced with No. 2 heating oil.

Table I-13 Stationary Source Fuel Throughput by Fuel Category (gallons)

Fuel Category	1999	2000	2001	2002	2003	2004	2005	2006	2007
Natural Gas (ft^3)	183,943,000	283,720,049	199,500,000	268,359,282	201,714,114	62,610,000	92,460,000	112,390,000	338,430,000
Heating Oil No. 2	480,733	494,500	582,283	340,492	370,903	381,852	367,899	259,768	423,181
Heating Oil No. 6[1]	1,600,893	1,555,527	1,641,693	1,079,283	1,122,975	2,940,752	3,098,126	1,396,529	1,073,260
Diesel Fuel[2]	57,441	N/A	N/A	N/A	N/A	67,198	77,848	77,848	258,606
Fire Training Fuel[3]	23,000	N/A	N/A	N/A	13,719	12,227	8,105	5,000	8,631

Fuel Category	2008	2009	2010	2011	2012	2013	2014	2015	2016
Natural Gas (ft^3)	458,680,000	430,810,000	449,640,000	479,830,000	360,523,000	402,496,000	418,805,000	463,170,000	429,502,000
Heating Oil No. 2	303,143	409,050	319,727	384,906	210,794	289,665	289,956	294,704	520,977
Heating Oil No. 6[1]	16,385	368,690	9,010	11,285	6,786	17,721	77,146	0	0
Diesel Fuel[2]	146,718	145,778	116,511	218,081	42,109	231,130	124,480	381,581	90,850
Fire Training Fuel[3]	5,971	3,510	800	3,810	2,587	5,400	3,753	7,619	6,153

Fuel Category	2017
Natural Gas (ft^3)	491,356,303
Heating Oil No. 2	115,878
Heating Oil No. 6[1]	0
Diesel Fuel[2]	157,243
Fire Training Fuel[3]	5,211

Source: Massport, 2019.
N/A Not available.
1 Effective November 2014, Massport no longer uses No. 6 heating oil at the Central Heating and Cooling Plant and was replaced with No. 2 heating oil.
2 Diesel fuel was from the stationary snow melter usage. Starting in 2007, portable snow melter usage was also included.
3 Fire Training Fuel used in 1999-2002 was Jet A Fuel while in 2003 through 2015 it was Tek-Flame®. 2012 includes 100 gallons of AvGas, 2013 includes 400 gallons of AvGas, 2014 includes 338 gallons of AvGas, 2015 includes 742 gallons of AvGas, 2016 includes 494 gallons of AvGas, and 2017 includes 1,241 gallons of AvGas.

Tables I-14 through **I-20** contain the 1993 through 2009 Emissions Inventory summary tables for Logan Airport.

Table I-14 Estimated VOC Emissions (in kg/day) at Logan Airport 1993-2001[1]

Aircraft/GSE Model:	**Logan Dispersion Modeling System (LDMS)**					**EDMS v3.22**	**EDMS v4.21**	**EDMS v4.03**	
Motor Vehicle Model:	**MOBILE5a**					**MOBILE 5a_h**	**MOBILE 6.2.03**	**MOBILE 6.0**	
Year:	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999[2]**	**2000**	**2001**
Aircraft Sources									
Air carriers	1,958	1,554	1,407	1,390	1,227	736	653	514	374
Commuter aircraft	943	543	531	622	498	154	196	140	113
Cargo aircraft	89	244	236	214	207	43	318	207	149
General aviation	51	48	36	24	27	13	141	42	43
Total aircraft sources	3,041	2,389	2,210	2,250	1,959	946	1,308	903	679
GSE[3]	636	533	521	497	530	145	243	153	143
Motor Vehicles									
Ted Williams Tunnel through-traffic	N/A	N/A	N/A	N/A	N/A	N/A	15	12	10
Parking/curbside	173	148	127	102	102	118	101	89	77
On-airport vehicles[4]	238	215	179	223	205	258	256	206	170
Total motor vehicle sources	411	363	306	325	307	376	372	307	257
Other Sources									
Fuel storage/handling	408	434	318	356	381	372	352	412	372
Miscellaneous sources[5]	5	5	5	6	6	2	16	2	2
Total other sources	413	439	323	362	387	374	368	414	374
Total Airport Sources	4,501	3,724	3,360	3,434	3,183	1,841	2,291	1,777	1,453

Source: KBE and Massport. 2019.
Notes: GSE – ground service equipment; N/A - not available; VOC – volatile organic compound.
kg/day Kilograms per day. One kg/day is approximately equivalent to 0.40234 tons per year (tpy).
1 The emissions inventory for 1990 is shown in Chapter 7, *Air Quality/Emissions Reduction*. Emission inventories for 1991 and 1992 were not prepared.
2 Year 1999 emissions were last re-calculated using EDMS v4.21 in the *2004 ESPR* Air Quality Analysis.
3 Beginning in 1996 and later, emissions include vehicles and equipment converted to alternative fuels. Auxiliary power unit (APU) emissions are also included.
4 1999 emissions inventory include reductions attributable to compressed natural gas (CNG) shuttle buses.
5 Includes the Central Heating and Cooling Plant, emergency electricity generation, and other stationary sources. Fire Training emissions were included in 1999. Diesel snow melter usage was added in 1999.

Table I-15 Estimated VOC Emissions (in kg/day) at Logan Airport 2002-2009

Aircraft/GSE Model:	**EDMS v4.11**		**EDMS v4.21**	**EDMS v4.5**		**EDMS v5.0.1**		**EDMS v5.0.2**		**EDMS v5.1**		**EDMS v5.1.2**
Motor Vehicle Model:	**MOBILE 6.0**	**MOBILE 6.2.01**	**MOBILE 6.2.03**									
Year:	**2002**	**2003**	**2004**	**2005**	**2006**		**2007**		**2008**		**2009**	
Aircraft Sources												
Air carriers	248	208	292	271	227	511	435	381	324	286	237	235
Commuter aircraft	75	95	127	140	125	371	479	409	253	176	131	133
Cargo aircraft	127	94	110	41	19	46	129	112	107	70	71	71
General aviation	52	61	127	147	147	236	226	206	201	171	78	78
Total aircraft sources	502	458	656	599	518	1,164[1]	1,269	1,108	885	703	517	517
GSE[2]	247	227	187	178	167	77	78	78	66	66	56	56
Motor Vehicles												
Ted Williams Tunnel through-traffic	9	0[3]	0[3]	0[3]	0[3]	0[3]	0[3]	0[3]	0[3]	0[3]	0[3]	0[3]
Parking/curbside[4]	51	45	38	37	33	33	31	31	25	25	22	22
On-airport vehicles	152	135	129	118	106	106	104	104	82	82	71	71
Total motor vehicle sources	212	180	167	155	139	139	135	135	107	107	93	93
Other Sources												
Fuel storage/handling	329	297	341	340	336	336	338	338	320	320	307	307
Miscellaneous sources[5]	2	3	9	13	8	8	14	14	13	12	7	7
Total other sources	331	300	350	353	344	344	352	352	333	332	314	314
Total Airport Sources	1,292	1,165	1,360	1,285	1,168	1,724	1,834	1,673	1,391	1,208	980	980

Source: KBE and Massport, 2019.
Notes: GSE – ground service equipment; VOC – volatile organic compound.
Years 2006 to 2009 were computed with previous years EDMS version to provide for a common basis of comparison.
Kg/day Kilograms per day. One kg/day is equivalent to approximately 0.40234 tons per year (tpy).
1 The 2006 increase in aircraft VOC emissions is largely attributable to the addition of aircraft main engine startup emissions.
2 GSE emissions include aircraft auxiliary power units (APUs) as well as vehicles and equipment converted to alternative fuels.
3 Due to the new roadway configuration and opening of the Ted Williams Tunnel there was no Ted Williams Tunnel through-traffic at Logan Airport beginning in 2003.
4 Parking/curbside is based on vehicle miles traveled (VMT) analysis.
5 Includes the Central Heating and Cooling Plant, emergency electricity generation, snow melter usage, and other stationary sources.

Table I-16 Estimated NO_X Emissions (in kg/day) at Logan Airport 1993-2001[1]

Aircraft/GSE Model:	Logan Dispersion Modeling System (LDMS)					EDMS v3.22	EDMS v4.21	EDMS v4.03	
Motor Vehicle Model:	**MOBILE5a**					**MOBILE 5a_h**	**MOBILE 6.2.03**	**MOBILE 6.0**	
Year:	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999[2]**	**2000**	**2001**
Aircraft Sources									
Air carriers	4,271	4,317	3,861	3,781	4,150	4,471	4,183	4,202	3,707
Commuter aircraft	202	158	192	137	159	203	166	125	233
Cargo aircraft	213	257	332	363	262	254	286	284	267
General aviation	13	13	17	18	21	5	12	49	34
Total aircraft sources	4,699	4,745	4,402	4,299	4,592	4,933	4,647	4,660	4,241
GSE[3]	722	617	607	588	622	317	444	333	305
Motor Vehicles									
Ted Williams Tunnel through-traffic	N/A	N/A	N/A	N/A	N/A	N/A	28	26	22
Parking/curbside	25	24	24	24	24	37	39	52	46
On-airport vehicles[4]	240	239	229	257	244	372	449	425	369
Total motor vehicle sources	265	263	253	281	268	409	516	503	437
Other Sources									
Fuel storage/handling[5]	0	0	0	0	0	0	0	0	0
Miscellaneous sources[6]	278	330	320	275	244	284	165	211	185
Total other sources	278	330	320	275	244	284	165	211	185
Total Airport Sources	5,964	5,955	5,582	5,443	5,726	5,943	5,772	5,707	5,168

Source: KBE and Massport, 2019.
Notes: GSE – ground service equipment; N/A – not available; NOx – oxides of nitrogen.
Kg/day Kilograms per day. One kg/day is approximately equivalent to 0.40234 tons per year (tpy).
1 The emissions inventory for 1990 is shown in Chapter 7, *Air Quality/Emissions Reduction*. Emission inventories for 1991 and 1992 were not prepared.
2 Year 1999 emissions were last re-calculated using EDMS v4.21 in the 2004 ESPR Air Quality Analysis.
3 Beginning in 1996 and later, emissions include vehicles and equipment converted to alternative fuels. Auxiliary power unit (APU) emissions are also included.
4 1999 emissions inventory include reductions attributable to compressed natural gas (CNG) shuttle buses.
5 Fuel storage and handling facilities are not sources of NOx emissions.
6 Includes the Central Heating and Cooling Plant, emergency electricity generation, and other stationary sources. Fire Training emissions were included in 1999. Diesel snow melter usage was added in 1999.

Table I-17 Estimated NO_X Emissions (in kg/day) at Logan Airport 2002-2009

Aircraft/GSE Model:	**EDMS v4.11**		**EDMS v4.21**	**EDMS v4.5**		**EDMS v5.0.1**		**EDMS v5.0.2**		**EDMS v5.1**		**EDMS v5.1.2**
Motor Vehicle Model:	**MOBILE 6.0**	**MOBILE 6.2.01**	**MOBILE 6.2.03**									
Year:	**2002**	**2003**	**2004**	**2005**	**2006**		**2007**		**2008**		**2009**	
Aircraft Sources												
Air carriers	2,721	2,479	2,949	2,880	2,849	3,044	3,120	3,121	3,031	3,031	2,944	2,952
Commuter aircraft	208	185	245	225	195	256	353	354	319	319	309	234
Cargo aircraft	246	213	215	211	192	125	248	248	233	233	215	204
General aviation	38	45	49	50	49	60	56	56	43	43	27	23
Total aircraft sources	3,213	2,922	3,458	3,366	3,285	3,485	3,777	3,779	3,626	3,626	3,495	3,413
GSE[1]	322	291	333	312	280	300	299	299	257	257	219	219
Motor Vehicles												
Ted Williams Tunnel through-traffic	20	0[2]	0[2]	0[2]	0[2]	0[2]	0[2]	0[2]	0[2]	0[2]	0[2]	0[2]
Parking/curbside[3]	32	28	21	22	19	19	18	18	15	15	13	13
On-airport vehicles	341	302	267	269	238	238	233	233	182	182	153	153
Total motor vehicle sources	393	330	288	291	257	257	251	251	197	197	166	166
Other Sources												
Fuel storage/handling[4]	0	0	0	0	0	0	0	0	0	0	0	0
Miscellaneous sources[5]	175	151	211	218	109	109	128	128	124	124	181	181
Total other sources	175	151	211	218	109	109	128	128	124	124	181	181
Total Airport Sources	4,103	3,694	4,290	4,187	3,931	4,151	4,455	4,457	4,204	4,204	4,061	3,979

Source: KBE and Massport, 2019.

Notes: GSE – ground serice equipment; NOx – oxides of nitrogen.
Years 2006 to 2009 were computed with previous years EDMS version to provide for a common basis of comparison.

Kg/day Kilograms per day. One kg/day is approximately equivalent to 0.40234 tons per year (tpy).

1 GSE emissions include auxiliary power units (APUs) as well as vehicles and equipment converted to alternative fuels.

2 Due to the new roadway configuration and opening of the Ted Williams Tunnel there was no Ted Williams Tunnel through-traffic at Logan Airport beginning in 2003.

3 Parking/curbside data is based on vehicle miles traveled (VMT) analysis.

4 Fuel storage/handling facilities are not a source of NOx emissions.

5 Includes the Central Heating and Cooling Plant, emergency electricity generation, snow melter usage, and other stationary sources.

Table I-18	Estimated CO Emissions (in kg/day) at Logan Airport 1993-2001[1]								
Aircraft/GSE Model:	**Logan Dispersion Modeling System (LDMS)**					**EDMS v3.22**	**EDMS v4.21**	**EDMS v4.03**	
Motor Vehicle Model:	**MOBILE5a**					**MOBILE 5a_h**	**MOBILE 6.2.03**	**MOBILE 6.0**	
Year:	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999[2]**	**2000**	**2001**
Aircraft Sources									
Air carriers	5,663	4,660	4,691	4,812	4,698	3,079	3,754	2,994	2,475
Commuter aircraft	1,309	927	934	859	770	482	1,404	1,188	1,072
Cargo aircraft	344	572	598	580	514	218	503	400	323
General aviation	353	356	339	549	654	269	940	295	407
Total aircraft sources	7,669	6,515	6,562	6,800	6,636	4,048	6,601	4,877	4,277
GSE[3]	7,482	6,187	6,029	5,740	6,098	5,113	4,532	5,335	5,193
Motor Vehicles									
Ted Williams Tunnel through-traffic	N/A	N/A	N/A	N/A	N/A	N/A	151	133	121
Parking/curbside	952	820	650	644	586	772	437	495	440
On-airport vehicles[4]	1,575	1,451	1,087	1,514	1,283	1,883	2,547	2,245	2,001
Total motor vehicle sources	2,527	2,271	1,737	2,158	1,869	2,655	3,135	2,873	2,562
Other Sources									
Fuel storage/handling[5]	0	0	0	0	0	0	0	0	0
Miscellaneous sources[6]	26	30	29	39	37	37	168	27	24
Total other sources	26	30	29	39	37	37	168	27	24
Total Airport Sources	17,704	15,003	14,357	14,737	14,640	11,853	14,436	13,112	12,056

Source: KBE and Massport, 2019.
Notes: CO – carbon monoxide; GSE – ground service equipment; N/A – not available.
Kg/day Kilograms per day. One kg/day is approximately equivalent to 0.40234 tons per year (tpy).
1 The emissions inventory for 1990 is shown in Chapter 7, *Air Quality/Emission Reduction*. Emission inventories for 1991 and 1992 were not prepared.
2 Year 1999 emissions were last re-calculated using EDMS v4.21 in the 2004 ESPR Air Quality Analysis.
3 Beginning in 1996 and later, emissions include vehicles and equipment converted to alternative fuels. Auxiliary power unit (APU) emissions are also included.
4 1999 emission inventory include reductions attributable to compressed natural gas (CNG) shuttle buses.
5 Fuel storage and handling facilities are not sources of CO emissions.
6 Includes the Central Heating and Cooling Plant, emergency electricity generation, and other stationary sources. Fire Training emissions were included in 1999. Diesel snow melter usage was added in 1999.

Table I-19 Estimated CO Emissions (in kg/day) at Logan Airport 2002-2009

Aircraft/GSE Model:	EDMS v4.11		EDMS v4.21	EDMS v4.5		EDMS v5.0.1		EDMS v5.0.2		EDMS v5.1		EDMS v5.1.2
Motor Vehicle Model:	**MOBILE 6.0**	**MOBILE 6.2.01**	**MOBILE 6.2.03**									
Year:	**2002**	**2003**	**2004**	**2005**	**2006**		**2007**		**2008**		**2009**	
Aircraft Sources												
Air carriers	2,156	2,128	2,985	2,895	2,828	3,167	2,973	2,973	2,710	2,710	2,460	2,448
Commuter aircraft	783	846	1,010	1,010	950	1,587	2,484	2,484	2,436	2,436	2,364	2,795
Cargo aircraft	285	209	229	174	138	158	241	241	255	255	256	266
General aviation	256	276	416	437	398	442	401	403	345	345	145	150
Total aircraft sources	3,480	3,459	4,640	4,516	4,314	5,354	6,099	6,101	5,746	5,746	5,225	5,659
Ground Service Equipment[1]	5,170	4,758	3,586	3,531	3,409	1,586	1,904	1,904	1,609	1,609	1,364	1,364
Motor Vehicles												
Ted Williams Tunnel through-traffic	112	0[2]	0[2]	0[2]	0[2]	0[2]	0[2]	0[2]	0[2]	0[2]	0[2]	0[2]
Parking/curbside[3]	295	253	180	179	144	144	139	139	117	117	107	107
On-airport vehicles	1,872	1,685	1,412	1,290	1,036	1,036	1,038	1,038	834	834	740	740
Total motor vehicle sources	2,279	1,938	1,592	1,469	1,180	1,180	1,177	1,177	951	951	847	847
Other Sources												
Fuel storage/handling[4]	0	0	0	0	0	0	0	0	0	0	0	0
Miscellaneous sources[5]	23	22	33	40	24	24	51	51	55	55	55	55
Total other sources	23	22	33	40	24	24	51	51	55	55	55	55
Total Airport Sources	10,952	10,177	9,851	9,556	8,927	8,144	9,231	9,233	8,361	8,361	7,491	7,925

Source: KBE and Massport, 2019.
Notes: CO – carbon monoxide; GSE – ground service equipment.
Kg/day Kilograms per day. One kg/day is approximately equivalent to 0.40234 tons per year (tpy).
Years 2006 to 2009 were computed with previous years EDMS version to provide for a common basis of comparison.
1 GSE emissions include auxiliary power units (APUs) as well as vehicles and equipment converted to alternative fuels.
2 Due to the new roadway configuration and opening of the Ted Williams Tunnel there was no Ted Williams Tunnel through-traffic at Logan Airport beginning in 2003.
3 Parking/curbside information is based on vehicle miles traveled (VMT) analysis.
4 Fuel storage/handling facilities are not a source of carbon monoxide (CO) emissions.
5 Includes the Central Heating and Cooling Plant, emergency electricity generation, snow melter usage, and other stationary sources.

Table I-20 Estimated $PM_{10}/PM_{2.5}$ Emissions (in kg/day) at Logan Airport, 2005-2009[1,2]

Aircraft/GSE Model:	**EDMS v4.5**		**EDMS v5.0.1**		**EDMS v5.0.2**		**EDMS v5.1**		**EDMS v5.1.2**
Motor Vehicle Model:	**MOBILE 6.2.03**								
Year:	**2005**	**2006**		**2007**		**2008**		**2009**	
Aircraft Sources									
Air carriers	25	25	38	35	67	63	42	43	36
Commuter aircraft	1	1	2	6	14	11	6	5	5
Cargo aircraft	2	3	2	3	6	5	4	4	3
General aviation	2	2	2	2	5	5	4	2	2
Total aircraft sources	30	31	44	46	92	84	56	54	46
GSE[3]	11	9	9	10	10	8	15	14	14
Motor Vehicles									
Parking/curbside[4]	1	1	1	<1	<1	<1	<1	<1	<1
On-airport vehicles	8	8	8	9	9	7	7	6	6
Total motor vehicle sources	9	9	9	9	9	7	7	6	6
Other Sources									
Fuel storage/handling[5]	0	0	0	0	0	0	0	0	0
Miscellaneous sources[6]	34	16	16	17	17	3	3	5	5
Total other sources	34	16	16	17	17	3	3	5	5
Total Airport Sources	84	65	78	82	128	102	81	79	71

Source: KBE and Massport, 2019.
Notes: GSE – ground service equipment; PM – particulate matter.
Kg/day Kilograms per day. One kg/day is approximately equivalent to 0.40234 tons per year (tpy);
Years 2006 to 2009 were computed with previous years EDMS version to provide for a common basis of comparison.
1 It is assumed that all PM are less than 2.5 microns in diameter ($PM_{2.5}$).
2 2005 is the first year that $PM_{10}/PM_{2.5}$ emissions were included in the Logan Airport ESPR/EDR emission inventories.
3 GSE emissions include auxiliary power units (APUs) as well as vehicles and equipment converted to alternative fuels.
4 Parking/curbside is based on vehicle miles traveled (VMT) analysis.
5 Fuel storage and handling facilities are not sources of PM emissions.
6 Includes the Central Heating and Cooling Plant, emergency electricity generation, fire training, snow melters, and other stationary sources.

Greenhouse Gas (GHG) Emissions Inventory for 2017

The Massachusetts Executive Office of Energy and Environmental Affairs (EEA) has published the *MEPA Greenhouse Gas Emissions Policy and Protocol*.[2] These guidelines require that certain projects undergoing review under the Massachusetts Environmental Policy Act (MEPA) quantify the greenhouse gas (GHG) emissions generated by proposed projects, and identify measures to avoid, minimize, or mitigate such emissions.[3] Even though the *2017 ESPR* does not assess any proposed projects and is therefore not subject to the GHG policy, Massport has prepared an emission inventory of GHG emissions directly and indirectly associated with Logan Airport.

In April 2009, the Transportation Research Board Airport Cooperative Research Program (ACRP); published the *Guidebook on Preparing Airport Greenhouse Gas Emission Inventories (ACRP Report 11)*, which provides recommended instructions to airport operators on how to prepare an airport-specific GHG emissions inventory.[4] The 2017 GHG emissions estimates include aircraft (within the ground taxi/delay and up to 3,000 feet), GSE, APU, motor vehicles, a variety of stationary sources, and electricity usage. Aircraft cruise emissions over the 3,000-foot level were not included. This work was accomplished following the EEA guidelines and uses widely-accepted emission factors that are considered appropriate for this application, including International Organization for Standardization New England electricity-based values.

Methodology

Airport GHG emissions are calculated in much the same way as criteria pollutants,[5] through the use of input data such as activity levels or material throughput rates (i.e., fuel usage, VMT, electrical consumption) that are applied to appropriate emission factors (i.e., in units of GHG emissions per gallon of fuel).

In this case, the input data were either based on Massport records, or data and information derived from the latest version of the FAA AEDT (AEDT 2d). **Table I-21** summarizes the data and information used in the 2017 GHG inventory.

Massport will update the GHG Emissions Inventory for Logan Airport annually.

---

2 Revised MEPA Greenhouse Gas Emissions Policy and Protocol, Massachusetts Executive Office of Energy and Environmental Affairs, effective May 10, 2010.

3 These GHGs are comprised primarily of carbon dioxide (CO_2), methane (CH_4), nitrous oxides (N_2O), and three groups of fluorinated gases (i.e., sulfur hexafluoride [SF_6], hydrofluorocarbons [HFCs], and perfluorocarbons [PFCs]). GHG emission sources associated with airports are generally limited to CO_2, CH_4, and N_2O.

4 Transportation Research Board, Airport Cooperative Research Panel, ACRP Report 11, Project 02-06, Guidebook on Preparing Airport Greenhouse Gas Emissions Inventories (in production). See http://onlinepubs.trb.org/onlinepubs/acrp/acrp_rpt_011.pdf for the full report.

5 Criteria pollutants are pollutants for which there are National Ambient Air Quality Standards (NAAQS) (i.e., carbon monoxide, sulfur dioxide, nitrogen dioxide, etc.).

Table I-21 Logan Airport Greenhouse Gas (GHG) Inventory Input Data and Information for 2017

Activity	Fuel Type	Usage	Units	Source
Aircraft				
Aircraft Taxi	Jet A[1]	20,614,471	gallons	AEDT 2d
	AvGas[2]	471	gallons	AEDT 2d
Engine Startup[6]	Jet A	476,387	gallons	AEDT 2d
Aircraft AGL to 3,000 feet	Jet A[1]	24,415,674	gallons	AEDT 2d
	AvGas[2]	558	gallons	AEDT 2d
Aircraft Support Equipment				
Ground Service Equipment (GSE)	Diesel	792,080	gallons	Massport
	Gasoline	667,637	gallons	Massport
	Propane	782	gallons	AEDT 2d
	CNG	0	ft^3	AEDT 2d
Auxiliary Power Units (APU)	Jet A	1,136,445	gallons	AEDT 2d
Motor Vehicles				
On-airport Vehicles	Composite[3]	71,723,449	VMT	Massport
On-airport Parking/Curbsides	Composite[3]	1,465,163	Idle hours	Massport
Massport Shuttle Bus	CNG	302,389	GEG	Massport
	Diesel	Defleeted 2014	gallons	Massport
Massport Express Bus	Diesel	534,761	gallons	Massport
Massport Fire Rescue	Diesel	20,000	gallons	Massport
Agricultural Equipment	Diesel	63,503	gallons	Massport
Massport Fleet Vehicles (Honda Civic)	CNG	423	GEG	Massport
Massport Fleet Vehicles (Fueled Onsite)	Gasoline	237,938	gallons	Massport
Massport Fleet Vehicles (Fueled Offsite)	Gasoline	85,501	gallons	Massport
Massport Fleet Vehicles (Fueled Onsite)	Diesel	86,365	gallons	Massport
Off-airport Vehicles (Public)	Composite[3]	220,681,409	VMT	Massport
Off-airport Vehicles (Airport Employees)	Composite[3]	5,866,364	VMT	Massport
Off-airport Vehicles (Tenant Employees)	Composite[3]	54,987,273	VMT	Massport

6 The EDMS fuel usage for Aircraft Engine Startup was reported as a surrogate because AEDT does not calculate this fuel usage.

Table I-21 Logan Airport Greenhouse Gas (GHG) Inventory Input Data and Information for 2017 (Continued)

Activity	Fuel Type	Usage	Units	Source
Stationary and Portable Sources				
Boilers and Space Heaters	No 2 Oil	115,878	gallons	Massport
	No 6 Oil	0	gallons	Massport
	Natural Gas	477	million ft^3	Massport
Generators	Diesel	36,330	gallons	Massport
Snow melters	ULSD	474	gallons	Massport
	CNG	5	million ft^3	Massport
Fire Training Facility	Tekflame	3,970	gallons	Massport
	AvGas	1,241	gallons	Massport
Electrical Consumption – Massport	-	16,074,695	kWh	Massport
Electrical Consumption – Tenant/Common Area	-	173,338,058	kWh	Massport

Sources: Massport and KBE, 2019.
Notes: AGL – above ground level; CNG – compressed natural gas; GEG – gasoline equivalent gallons; kWh – kilowatt hours; ULSD – ultra low sulfur diesel; VMT – vehicle miles traveled.
1 Jet A density of 6.84 pounds per gallon.
2 AvGas density of 6.0 pounds per gallon.
3 Composite means gasoline, diesel, CNG, and liquefied petroleum gas (LPG) fueled motor vehicles.

Emission factors were obtained from the U.S. Energy Information Administration, the Intergovernmental Panel on Climate Change (IPCC), EPA's MOVES, and the most recent version of EPA's GHG Emission Factors Hub (March 2018).[7,8,9,10] **Table I-22** presents emission factors for carbon dioxide (CO_2), nitrous oxide (N_2O), and methane (CH_4) for 2017.

7 IPCC Guidelines for National Greenhouse Gas Inventories, Volume 2, 2006, www.ipcc-nggip.iges.or.jp/public/2006gl/index.html.
8 U.S. Energy Information Administration, Voluntary Reporting of Greenhouse Gases Program. Fuel and Energy Source Codes and Emission Coefficients, www.eia.doe.gov/oiaf/1605/coefficients.html.
9 EPA, GHG Emissions Factors Hub (March 2018) https://www.epa.gov/climateleadership/center-corporate-climate-leadership-ghg-emission-factors-hub. The most recent version of the Emission Factors Hub includes updates to emission factors for stationary and mobile combustion sources, new electricity emission factors from EPA's Emissions & Generation Resource Integrated Database (eGRID) and the IPCC Fifth Assessment Report (AR4/AR5).
10 U.S. Environmental Protection Agency, MOVES Emissions Model, http://www.epa.gov/otaq/models/moves/.

Table I-22 Greenhouse Gas (GHG) Emission Factors for 2017

Sources	Fuel	CO_2	N_2O	CH_4	Units
Aircraft[1]	Jet A	21.5	0.00066	-[5]	lb/gallon
	AvGas	18.3	0.00024	0.01556	lb/gallon
Ground Support Equipment (GSE)/ Auxiliary Power Units (APUs)[1]	Diesel	22.5	0.00057	0.00126	lb/gallon
	Gasoline	19.4	0.00049	0.00110	lb/gallon
	CNG	120.0	0.00023	0.00226	lb/1000 ft^3
	Propane	12.6	0.00011	0.00060	lb/gallon
	Jet A	21.5	0.00066	-[5]	lb/gallon
Motor Vehicles[1,2]	Composite	463	0.00004	0.00324	g/mile
	Composite	3,400	0.00017	0.0135	g/hour
	CNG	120.0	0.00023	0.00226	lb/1000 ft^3
	Diesel	22.5	0.00057	0.00126	lb/gallon
	Gasoline	19.4	0.00018	0.0008	lb/gallon
Stationary and Portable[1]	No. 2 Oil	22.5	0.00018	0.00090	lb/gallon
	No. 6 Oil	24.8	0.00020	0.00099	lb/gallon
	Natural Gas	120.0	0.00023	0.00226	lb/1000 ft^3
	ULSD	22.5	0.00018	0.00090	lb/gallon
Fire Training Facility[1]	Tekflame[3]	12.6	0.00011	0.00060	lb/gallon
	AvGas	18.3	0.00024	0.01556	lb/gallon
Electrical Consumption[4]	-	0.56	0.000009	0.000012	lb/kW-hr

Sources: Massport and KBE, 2019.
Notes: CH_4 – methane; CNG – compressed natural gas; CO_2 – carbon dioxide; g- grams; kWh – kilowatt hour; lb – pound; N_2O – nitrous oxides; ULSD – Ultra Low Sulfur Diesel.

1 Environmental Protection Agency, GHG Emissions Factors Hub (March 2018), https://www.epa.gov/climateleadership/center-corporate-climate-leadership-ghg-emission-factors-hub.

2 EPA, MOVES2014b, http://www.epa.gov/otaq/models/moves/.

3 As propane.

4 Environmental Protection Agency, Emissions & Generation Resource Integrated Database (eGRID2016), February 2018, http://www.epa.gov/climateleadership/documents/emission-factors.pdf.

5 Contributions of CH_4 emissions from commercial aircraft are reported as zero. Years of scientific measurement campaigns conducted at the exhaust exit plane of commercial aircraft gas turbine engines have repeatedly indicated that CH_4 emissions are consumed over the full emission flight envelope [Reference: Aircraft Emissions of Methane and Nitrous Oxide during the Alternative Aviation Fuel Experiment, Santoni et al., Environ. Sci. Technol., July 2011, Volume 45, pp. 7075-7082]. As a result, EPA published that: "…methane is no longer considered to be an emission from aircraft gas turbine engines burning Jet A at higher power settings and is, in fact, consumed in net at these higher powers." [Reference: EPA, Recommended Best Practice for Quantifying Speciated Organic Gas Emissions from Aircraft Equipped with Turbofan, Turbojet, and Turboprop Engines, May 27, 2009 [EPA-420-R-09-901], http://www.epa.gov/otaq/aviation.htm]. In accordance with the following statements in the 2006 IPCC Guidelines (IPCC 2006), FAA does not calculate CH_4 emissions for either the domestic or international bunker commercial aircraft jet fuel emissions inventories. "Methane (CH_4) may be emitted by gas turbines during idle and by older technology engines, but recent data suggest that little or no CH_4 is emitted by modern engines." "Current scientific understanding does not allow other gases (e.g., N_2O and CH_4) to be included in calculation of cruise emissions." (IPCC 1999).

Results

Table I-23 presents the results of the 2017 GHG emissions inventory for Logan Airport by emission source (i.e., aircraft, GSE, motor vehicles, and stationary sources) and compound (i.e., CO_2, N_2O, and CH_4), respectively.

Table I-23 Greenhouse Gas (GHG) Emissions (MMT CO_2 Eq)[1] for 2017

Activity	CO_2	N_2O	CH_4	Total
Aircraft Sources				
Aircraft Taxi	0.20	<0.01	<0.01	0.20
Engine Startup	<0.01	<0.01	-[2]	<0.01
Aircraft AGL to 3,000 feet	0.24	<0.01	<0.01	0.24
Aircraft Support Equipment				
Ground Service Equipment (GSE)	0.01	<0.01	<0.01	0.01
Auxilary Power Unit (APU)	0.01	<0.01	-[2]	0.01
Motor Vehicles				
On-airport Vehicles	0.03	<0.01	<0.01	0.03
On-airport Parking/Curbsides	<0.01	<0.01	<0.01	<0.01
Massport Shuttle Buses	0.01	<0.01	<0.01	0.01
Massport Fleet Vehicles	0.01	<0.01	<0.01	0.01
Off-airport Vehicles (Public)	0.07	<0.01	<0.01	0.07
Off-airport Vehicles (Airport Employees)	<0.01	<0.01	<0.01	<0.01
Off-airport Vehicles (Tenant Employees)	0.03	<0.01	<0.01	0.03
Stationary Sources				
Boilers	0.03	<0.01	<0.01	0.03
Generators, Snow melters, etc.	<0.01	<0.01	<0.01	<0.01
Fire Training Facility	<0.01	<0.01	<0.01	<0.01
Electrical Consumption	0.05	<0.01	<0.01	0.05

Sources: Massport and KBE, 2019.

Notes: AGL – above ground level; CH_4 – methane; CO_2 – carbon dioxide; N_2O – nitrous oxides.

1 Units expressed as million metric tons of CO_2 equivalent (MMT CO2 Eq): 1 metric ton = 1.1 short tons.

2 Contributions of CH_4 emissions from commercial aircraft are reported as zero. Years of scientific measurement campaigns conducted at the exhaust exit plane of commercial aircraft gas turbine engines have repeatedly indicated that CH_4 emissions are consumed over the full emission flight envelope [Reference: Aircraft Emissions of Methane and Nitrous Oxide during the Alternative Aviation Fuel Experiment, Santoni et al., Environ. Sci. Technol., July 2011, Volume 45, pp. 7075-7082]. As a result, EPA published that: "…methane is no longer considered to be an emission from aircraft gas turbine engines burning Jet A at higher power settings and is, in fact, consumed in net at these higher powers." [Reference: EPA, Recommended Best Practice for Quantifying Speciated Organic Gas Emissions from Aircraft Equipped with Turbofan, Turbojet, and Turboprop Engines, May 27, 2009 [EPA-420-R-09-901], http://www.epa.gov/otaq/aviation.htm]. In accordance with the following statements in the 2006 IPCC Guidelines (IPCC 2006), FAA does not calculate CH_4 emissions for either the domestic or international bunker commercial aircraft jet fuel emissions inventories. "Methane (CH_4) may be emitted by gas turbines during idle and by older technology engines, but recent data suggest that little or no CH_4 is emitted by modern engines." "Current scientific understanding does not allow other gases (e.g., N_2O and CH_4) to be included in calculation of cruise emissions." (IPCC 1999).

Table I-24 compares the total GHG emission from Logan Airport in 2017 to the total GHG emissions for Massachusetts.

Table I-24 Logan Airport Greenhouse Gas (GHG) Emissions Compared to Massachusetts Totals[1]

	CO_2	N_2O	CH_4	Totals
Logan Airport Emissions (2017)[2]	0.70	<0.01	<0.01	0.71
Massachusetts[3]	71.78	0.8	1.2	73.77
Percent of Logan Airport to Massachusetts[4]	<1%	<1%	<1%	<1%

Sources: Massport and KBE, 2019.
Notes: CH_4 – methane; CO_2 – carbon dioxide; N_2O – nitrous oxides.
1 Units expressed as million metric tons of CO_2 equivalents (MMT CO_2 Eq): 1 metric ton = 1.1 short tons.
2 Total from Massport, tenants, and public categories.
3 Climate Analysis Indicators Tool (CAIT US) Version 4.0. (Washington, DC: World Resources Institute, 2015)
4 Percentages represent the relative amount Logan Airport-related emissions compared to the state totals.

Table I-25 provides a comparison between Airport-related GHG emissions from 2007 through 2017. Total GHG emissions in 2017 were slightly higher (8 percent) than 2016 levels. To equally compare to previous years, the 2017 emissions are summarized in a manner similar to previous years.

Table I-25 Comparison of Estimated Total Greenhouse Gas (GHG) Emissions (MMT of CO_2eq) at Logan Airport – 2007 through 2017

Source	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Direct Emissions[2]											
Aircraft[3]	0.22	0.21	0.19	0.18	0.19	0.19	0.19	0.20	0.21	0.19	0.21
GSE/APUs	0.08	0.08	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.01	0.03
Motor vehicles[4]	0.03	0.03	0.03	0.03	0.04	0.03	0.05	0.05	0.05	0.05	0.05
Other sources[5]	0.04	0.03	0.03	0.03	0.03	0.02	0.03	0.03	0.03	0.03	0.03
Total Direct Emissions	0.37	0.35	0.27	0.27	0.28	0.26	0.29	0.29	0.32	0.29	0.32
Indirect Emissions[6]											
Aircraft[7]	0.18	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.18	0.22	0.24
Motor vehicles[8]	0.05	0.05	0.05	0.05	0.06	0.05	0.08	0.07	0.08	0.09	0.10
Electrical consumption[9]	0.09	0.08	0.07	0.07	0.08	0.08	0.06	0.06	0.06	0.06	0.05
Total Indirect Emissions	0.32	0.30	0.29	0.29	0.30	0.30	0.31	0.30	0.32	0.36	0.39
Total Emissions[10]	0.69	0.65	0.56	0.56	0.58	0.57	0.60	0.60	0.63	0.65	0.71
Percent of State Totals[11]	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1

Sources: Massport and KBE, 2019.

Notes: APU – Auxiliary Power Unit; CH_4 – methane; CO_2 – carbon dioxide; GSE- Ground Service Equipment; N_2O – nitrous oxides. Totals may not add exactly due to rounding.

1 MMT – million metric tons of CO_2 equivalents (1 MMT = 1.1M Short Tons). CO_2 equivalents (CO_2eq) are bases for reporting the three primary GHGs (e.g., CO_2, N_2O and CH_4) in common units. Quantities are reported as "rounded" and truncated values for ease of addition.

2 Direct emissions are those that occur in areas located within the Airport's geographic boundaries.

3 Direct aircraft emissions-based engine start-up, taxi-in, taxi-out and ground-based delay emissions.

4 Direct motor vehicle emissions based on on-site vehicle miles traveled (VMT).

5 Other sources include Central Heating and Cooling Plant, emergency generators, snow melters and live fire training facility.

6 Indirect emissions are those that occur off the Airport site.

7 Indirect aircraft emissions are based on take-off, climb-out and landing emissions which occur up to an altitude of 3,000 ft., the limits of the landing and takeoff (LTO) cycle

8 Indirect motor vehicle emissions based on off-site Airport-related VMT and an average round trip distance of approximately 60 miles.

9 Electrical consumption emissions occur off-airport at power generating plants.

10 Total Emissions = Direct + Indirect.

11 Percentage based on relative amount of Airport total of direct emissions to statewide total from World Resources Institute (cait.wri.org).

Greenhouse Gas (GHG) Emissions Inventory for the Future Planning Horizon

Methodology

Airport GHG emissions for the Future Planning Horizon are calculated in the same manner as for 2017, through the use of input data such as activity levels or material throughput rates (i.e., fuel usage, VMT, electrical consumption) that are applied to appropriate emission factors (i.e., in units of GHG emissions per gallon of fuel). Activity levels and material throughput rates were estimated based on scaling the 2017 data (or recent five-year average) to the Future Planning Horizon as a function of the forecasted changes in aircraft operations, traffic volumes, passenger counts, terminal square footage, or similar matrices over this timeframe. Generally, these estimates represent a conservative calculation of the activity and material rates during the Future Planning Horizon and thus, a conservative estimate of the GHG emissions. **Table I-26** summarizes these data and information used in the future GHG emissions inventory

Table I-26 Logan Airport Greenhouse Gas (GHG) Inventory Input Data and Information for the Future Planning Horizon

Activity	Fuel Type	Usage	Units	Source
Aircraft				
Aircraft Taxi	Jet A[1]	24,227,870	gallons	AEDT 2d
	AvGas[2]	465	gallons	AEDT 2d
Engine Startup	Jet A	588,487	gallons	AEDT 2d
Aircraft AGL to 3,000 feet	Jet A[1]	33,463,625	gallons	AEDT 2d
	AvGas[2]	642	gallons	AEDT 2d
Aircraft Support Equipment				
Ground Service Equipment (GSE)	Diesel	79,208	gallons	Massport
	Gasoline	66,764	gallons	Massport
	Propane	0	gallons	AEDT 2d
	CNG	0	ft^3	AEDT 2d
Auxiliary Power Units (APU)	Jet A	1,173,139	gallons	AEDT 2d
Motor Vehicles				
On-airport Vehicles	Composite[3]	65,252,598	VMT	Massport
On-airport Parking/Curbsides	Composite[3]	1,714,049	Idle hours	Massport
Massport Shuttle Bus	CNG	394,505	GEG	Massport
	Diesel	Defleeted 2014	gallons	Massport
Massport Express Bus	Diesel	697,664	gallons	Massport

Table I-26	Logan Airport Greenhouse Gas (GHG) Inventory Input Data and Information for the Future Planning Horizon (Continued)			
Massport Fire Rescue	Diesel	20,000	gallons	Massport
Agricultural Equipment	Diesel	76,950	gallons	Massport
Massport Fleet Vehicles (Honda Civic)	CNG	512	GEG	Massport
Massport Fleet Vehicles (Fueled Onsite)	Gasoline	216,242	gallons	Massport
Massport Fleet Vehicles (Fueled Offsite)	Gasoline	64,126	gallons	Massport
Massport Fleet Vehicles (Fueled Onsite)	Diesel	78,490	gallons	Massport
Off-airport Vehicles (Public)	Composite[3]	287,907,074	VMT	Massport
Off-airport Vehicles (Airport Employees)	Composite[3]	4,461,726	VMT	Massport
Off-airport Vehicles (Tenant Employees)	Composite[3]	60,263,172	VMT	Massport
Stationary and Portable Sources				
Boilers and Space Heaters	No 2 Oil	20,475	gallons	Massport
	No 6 Oil	0	gallons	Massport
	Natural Gas	534	million ft^3	Massport
Generators	Diesel	63,653	gallons	Massport
Snow melters	ULSD	474	gallons	Massport
	CNG	16	million ft^3	Massport
Fire Training Facility	Tekflame	4,984	gallons	Massport
	AvGas	643	gallons	Massport
Electrical Consumption – Massport	-	19,890,762	kWh	Massport
Electrical Consumption – Tenant/Common Area	-	214,487,805	kWh	Massport

Sources: Massport and KBE, 2019.
Notes: AGL – above ground level; CNG – compressed natural gas; GEG – gasoline equivalent gallons;; kWh – kilowatt hours; VMT – vehicle miles traveled; ULSD – ultra low sulfur diesel.
1 Jet A density of 6.84 pounds per gallon.
2 AvGas density of 6.0 pounds per gallon.
3 Composite means gasoline, diesel, CNG, and liquefied petroleum gas (LPG) fueled motor vehicles.

Results

Table I-27 presents the results of the future GHG emissions inventory for Logan Airport by emission source (i.e., aircraft, GSE, motor vehicles, and stationary sources) and compound (i.e., CO_2, N_2O, and CH_4).

Table I-27 Greenhouse Gas (GHG) Emissions (MMT CO_2 Eq)[1] for the Future Planning Horizon

Activity	CO_2	N_2O	CH_4	Total
Aircraft Sources				
Aircraft Taxi	0.24	<0.01	-[2]	0.24
Engine Startup	0.01	<0.01	-[2]	0.01
Aircraft AGL to 3,000 feet	0.33	<0.01	<0.01	0.33
Aircraft Support Equipment				
Ground Service Equipment (GSE)	<0.01	<0.01	<0.01	<0.01
Auxiliary Power Unit (APU)	0.01	<0.01	-[2]	0.01
Motor Vehicles				
On-airport Vehicles	0.03	<0.01	<0.01	0.03
On-airport Parking/Curbsides	0.01	<0.01	<0.01	0.01
Massport Shuttle Buses	0.02	<0.01	<0.01	0.02
Massport Fleet Vehicles	<0.01	<0.01	<0.01	<0.01
Off-airport Vehicles (Public)	0.11	<0.01	<0.01	0.11
Off-airport Vehicles (Airport Employees)	<0.01	<0.01	<0.01	<0.01
Off-airport Vehicles (Tenant Employees)	0.03	<0.01	<0.01	0.03
Stationary Sources				
Boilers	0.03	<0.01	<0.01	0.03
Generators, Snow melters, etc.	<0.01	<0.01	<0.01	<0.01
Fire Training Facility	<0.01	<0.01	<0.01	<0.01
Electrical Consumption	0.06	<0.01	<0.01	0.06

Sources: Massport and KBE, 2019.
Notes: AGL – above ground level; CH_4 – methane; CO_2 – carbon dioxide; N_2O – nitrous oxides.
1 Units expressed as million metric tons of CO_2 equivalent (MMT CO_2 Eq): 1 metric ton = 1.1 short tons.
2 Contributions of CH_4 emissions from commercial aircraft are reported as zero. Years of scientific measurement campaigns conducted at the exhaust exit plane of commercial aircraft gas turbine engines have repeatedly indicated that CH_4 emissions are consumed over the full emission flight envelope [Reference: Aircraft Emissions of Methane and Nitrous Oxide during the Alternative Aviation Fuel Experiment, Santoni et al., Environ. Sci. Technol., July 2011, Volume 45, pp. 7075-7082]. As a result, EPA published that: "…methane is no longer considered to be an emission from aircraft gas turbine engines burning Jet A at higher power settings and is, in fact, consumed in net at these higher powers." [Reference: EPA, Recommended Best Practice for Quantifying Speciated Organic Gas Emissions from Aircraft Equipped with Turbofan, Turbojet, and Turboprop Engines, May 27, 2009 [EPA-420-R-09-901], http://www.epa.gov/otaq/aviation.htm]. In accordance with the following statements in the 2006 IPCC Guidelines (IPCC 2006), FAA does not calculate CH_4 emissions for either the domestic or international bunker commercial aircraft jet fuel emissions inventories. "Methane (CH_4) may be emitted by gas turbines during idle and by older technology engines, but recent data suggest that little or no CH_4 is emitted by modern engines." "Current scientific understanding does not allow other gases (e.g., N_2O and CH_4) to be included in calculation of cruise emissions." (IPCC 1999).

Measured NO_2 Concentrations

This section presents the results of Massport's long-term ambient (i.e., outdoor) air quality monitoring program for NO_2 – a pollutant associated with aircraft activity and other fuel combustion sources. Between 1982 and 2011, Massport collected NO_2 concentration data at numerous locations both on the Airport and in neighboring residential communities. The purpose of this monitoring program was to track long-term trends in NO_2 levels and to compare the results to the NAAQS for this pollutant. In 2011, Massport determined that the Logan NO_2 Monitoring Program had achieved its objectives with the significant and stable decrease in NO_2 emissions since 1999 and thus discontinued the program in 2011.

When it was operational, this monitoring program used passive diffusion tube technology for a period of one week each month for 12 months of the year at each of the monitoring stations. The samples of NO_2, along with Quality Assurance/Quality Control (QA/QC) samples, were then analyzed in a laboratory.

Table I-28 presents the final year NO_2 monitoring data (i.e., 2011). For comparative purposes, historical data from 1999 are similarly shown in **Table I-28**. The table also includes NO_2 data collected under a separate effort by the Massachusetts Department of Environmental Protection (MassDEP) using continuous monitors at four Boston-area locations.

As shown on **Table I-28**, the 2011 NO_2 levels were somewhat higher than in 2010. However, this occurrence is consistent with the cyclical trend of the average levels over the past several years[11]. Importantly, there remains a long-term trend of decreasing NO_2 concentrations at both the Massport and MassDEP monitoring sites since 1999. Other notable observations of the 2011 data reveal the following:

- Annual NO_2 concentrations at all Massport and MassDEP monitoring locations were below the annual NO_2 NAAQS of 100 micrograms per cubic meter (μg/m^3) in 2011.
- The Massport-collected data compare relatively closely with data collected by the MassDEP. The average of all Massport monitoring sites was 29.8 μg/m^3 compared to 32.3 μg/m^3 for the four MassDEP Boston-area monitors.
- The highest NO_2 concentrations in 2011 from the Massport program occurred in areas characterized by high levels of motor vehicle traffic (i.e., Main Terminal Area [Site 8] and Maverick Square [Site 12]).

11 Spatial and temporal changes in measured NO_2 levels from year to year are typical and should not be used to define short-term results. Rather, NO_2 levels are better assessed by looking at the trends over several years.

Table I-28 Massport and MassDEP Annual NO_2 Concentration Monitoring Results (µg/m³)

Monitoring Site	Site No.	Year 1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Massport Monitoring Sites														
Runway 9	1	61.0	58.2	41.6	45.8	33.9	30.1	35.0	31.9	17.3	31.3	32.2	32.3	38.7
Runway 4R	2	55.6	44.6	41.4	36.9	32.5	30.9	30.7	29.0	17.2	20.2	19.2	21.9	25.7
Runway 33L	3	47.7	42.6	39.4	33.3	30.8	25.4	24.5	26.3	24.2	21.6	16.9	25.0	29.8
Runway 27	4	42.9	37.8	35.8	30.3	25.5	24.1	22.7	22.3	16.9	18.3	17.6	19.4	23.3
Runaway 22L	5	47.5	39.8	38.2	33.8	27.8	23.7	22.1	24.9	17.1	21.3	20.1	21.9	29.0
Runway 22R	6	60.6	59.2	51.6	45.0	32.3	29.7	32.9	25.1	24.8	29.7	27.8	33.1	30.6
Runway 15R	7	47.0	43.4	44.3	42.6	40.8	28.7	27.7	28.7	20.5	24.2	23.9	26.7	29.7
Main Terminal Area	8	70.8	87.0	80.7	69.3	44.3	44.7	46.2	43.5	29.5	41.7	37.7	43.9	49.0
Webster St., Jeffries Point	11	52.4	45.5	43.4	39.1	32.5	28.3	31.3	31.3	22.7	25.2	23.9	27.0	30.1
Maverick Square, E. Bos	12	81.2	72.2	68.5	61.3	47.9	46.5	41.4	45.6	36.0	41.3	38.2	42.5	43.5
Bremen St., E. Boston	13	59.1	52.6	52.0	46.2	39.1	35.7	37.6	37.1	27.8	30.1	28.6	31.9	35.3
Shore St. E. Boston	14	45.7	38.5	38.8	35.0	27.2	24.0	24.9	22.4	18.1	19.7	18.3	20.7	26.7
Orient Heights Yacht Club	15	45.1	46.9	47.7	43.1	29.4	25.2	25.5	25.1	19.6	21.1	18.3	22.5	26.7
Bayswater St. E. Boston	16	45.2	45.5	48.3	41.2	28.4	22.8	30.4	23.1	18.4	20.2	17.8	21.0	25.9
Annavoy St. E. Boston	17	40.8	39.2	44.4	33.7	24.7	21.4	23.3	21.0	18.2	19.6	17.3	20.9	25.8
Pleasant St. Winthrop	18	42.0	39.3	37.8	32.3	27.9	22.6	23.4	21.4	17.8	20.2	17.7	20.1	24.4
Court Road, Winthrop	19	40.0	36.1	33.8	27.4	24.0	19.2	22.3	21.0	16.3	17.1	16.7	18.4	22.7
Cottage Park Yacht Club	20	37.1	50.9	45.9	36.7	22.5	19.1	27.7	21.4	16.3	18.4	17.8	17.8	22.5
Point Shirley, Winthrop	21	33.1	37.7	38.6	24.4	22.7	17.4	17.2	20.2	15.7	15.6	14.9	17.5	21.6
Deer Island	22	36.3	31.9	33.8	33.1	21.3	17.8	16.9	17.8	13.0	17.0	14.7	16.7	20.7
Runway 4R–9	23	42.2	66.0	42.3	33.4	28.6	24.1	27.1	26.3	19.2	22.4	21.2	21.6	26.5
Runway 33L–4R	24	44.3	41.7	41.8	33.5	28.1	24.3	22.3	25.7	20.9	25.2	20.0	23.6	26.2

Table I-28	Massport and MassDEP Annual NO_2 Concentration Monitoring Results (μg/m³) (Continued)													
Monitoring Site	**Site No.**	**Year**												
		1999	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**
Massport Monitoring Sites (continued)														
Runway 22R–33L	25	62.4	50.3	49.4	42.2	33.8	31.7	29.4	34.5	22.9	25.1	25.3	29.5	34.9
Jeffries Point Park/Marginal St.	26	68.6	49.8	45.0	42.0	35.2	30.5	32.5	31.7	24.4	27.0	25.6	28.6	33.1
Harborwalk	27	54.3	48.5	47.4	43.5	35.6	35.5	29.3	34.2	24.2	26.1	24.5	28.3	34.9
Logan Athletic Fields	29	NA	69.1	67.6	54.9	41.9	40.2	37.5	37.0	24.6	28.8	26.8	30.8	37.8
Brophy Park, Jeffries Point	30	NA	48.0	45.2	41.0	36.5	31.2	32.9	31.3	24.8	26.6	24.6	26.8	30.8
Average of all Monitoring Sites		**50.5**	**50.5**	**47.5**	**40.0**	**31.7**	**28.0**	**28.7**	**28.7**	**21.0**	**24.3**	**22.5**	**25.6**	**29.8**
MassDEP Monitoring Sites[1]														
Long Island Road	A	20.7	24.4	22.6	22.6	16.9	12.6	13.2	13.2	13.2	13.2	11.3	13.6	13.4
Harrison Avenue	B	NA	45.1	47.0	45.1	43.2	37.4	35.8	35.8	37.7	37.7	33.9	32.1	33.1
Kenmore Square	C	56.4	54.5	56.8	47.0	47.0	51.7	43.3	43.3	39.6	41.5	37.7	36.0	38.4
East First Street	D	39.5	37.6	43.2	39.5	39.5	36.8	33.9	39.6	37.7	30.2	28.3	24.0	25.4

Source: Massport and MassDEP.

Notes: MassDEP - Massachusetts Department of Environmental Protection; N/A – not available; NO_2 – oxides of nitrogen.
The National Ambient Air Quality Standard (NAAQS) is 100 μg/m³.
Massport determined that the Logan Airport NO_2 Monitoring Program had achieved its objectives with the significant and stable decrease in NO_2 emissions since 1999 and thus discontinued the program in 2011.
μg/m³ micrograms/cubic meter.

1 NO_2 monitoring sites operated by the MassDEP.

This Page Intentionally Left Blank.

J

Environmental Compliance and Management/Water Quality

This appendix provides detailed information in support of Chapter 8, *Environmental Compliance and Management/Water Quality*:

- Table J-13 Logan Airport February 2017 Wet Weather Deicing Monitoring Results — North, West, Porter Street, and Runway/Perimeter Stormwater Outfalls
- Table J-14 Logan Airport March 2017 Wet Weather Deicing Monitoring Results — North, West Porter Street, and Runway/Perimeter Stormwater Outfalls
- Table J-15 Logan Airport Stormwater Outfall NPDES Water Quality Monitoring Results — 1993 to 2017
- Table J-16 Logan Airport Oil and Hazardous Material Spills and Jet Fuel Handling — 1990 to 2017
- Table J-17 Type and Quantity of Oil and Hazardous Material Spills at Logan Airport — 1999 to 2017
- Table J-18 Massachusetts Contingency Plan (MCP) Closed Sites at Logan Airport
- Figure J-1 Massachusetts Contingency Plan Sites (Closed)
- EnviroNews/Sustainable Massport[1]

  Vol. 43, Issue 1 – May 2017

  Vol. 43, Issue 2 – September 2017

  Vol. 43, Issue 4 – December 2017

- Sustainable Massport Monthly Newsletters, 2018

  February 2018: Sustainable Transportation

  March 2018: Water Resources and Conservation

  April 2018: Health and Wellness

  May 2018: Parks and Open Space

  June 2018: Air Quality and Greenhouse Gas Reduction

  July 2018: Natural Resources

  August 2018: Climate Change Adaptation and Resiliency

  September 2018: Community Partnerships

  October 2018: Energy Efficiency

  November 2018: Waste Management and Recycling

  December 2018: Sustainable Tenants

---

1 Only three *Sustainable Massport* Newsletters were published in 2017.

Table J-1 Logan Airport NPDES Permit (No. MA0000787) Stormwater Outfall Monitoring Requirements (2007)

Monitoring Event	North Outfall 001		West Outfall 002		Maverick Outfall 003	
	Field Measurement	Laboratory Analysis	Field Measurement	Laboratory Analysis	Field Measurement	Laboratory Analysis
Monthly Dry Weather	Not Required	Oil and Grease TSS[1] Benzene Surfactant Fecal Coliform *Enterococcus*	Not Required	Oil and Grease TSS[1] Benzene Surfactant Fecal Coliform *Enterococcus*	Not Required	Oil and Grease TSS[1] Benzene Surfactant Fecal Coliform *Enterococcus*
Monthly Wet Weather	pH Flow Rate[6]	Oil and Grease TSS[1] Benzene[2] Surfactant Fecal Coliform *Enterococcus*	pH Flow Rate[6]	Oil and Grease TSS[1] Benzene[2] Surfactant Fecal Coliform *Enterococcus*	pH Flow Rate[6]	Oil and Grease TSS[1] Benzene[2] Surfactant Fecal Coliform *Enterococcus*
Quarterly Wet Weather	pH Flow Rate[6]	PAHs[3]: - Benzo(a)anthracene - Benzo(a)pyrene - Benzo(b)fluoranthene - Benzo(k)fluoranthene - Chrysene -Dibenzo(a,h)anthracene - Indeno(1,2,3-cd)pyrene - Naphthalene	pH Flow Rate[6]	PAHs[3]: - Benzo(a)anthracene - Benzo(a)pyrene - Benzo(b)fluoranthene - Benzo(k)fluoranthene - Chrysene -Dibenzo(a,h)anthracene - Indeno(1,2,3-cd)pyrene - Naphthalene	pH Flow Rate[6]	PAHs[3]: - Benzo(a)anthracene - Benzo(a)pyrene - Benzo(b)fluoranthene - Benzo(k)fluoranthene - Chrysene -Dibenzo(a,h)anthracene - Indeno(1,2,3-cd)pyrene - Naphthalene
Deicing Episode (2/Deicing Season)	Not Required	Ethylene Glycol Propylene Glycol BOD5[4] COD[5] Total Ammonia Nitrogen Nonylphenol Tolyltriazole	Not Required	Ethylene Glycol Propylene Glycol BOD5[4] COD[5] Total Ammonia Nitrogen Nonylphenol Tolyltriazole	Not Required	Not Required
Whole Effluent Toxicity (1st and 3rd Year Deicing Season)	Not Required	Menidia beryllina Arbacia punctulata	Not Required	Menidia beryllina Arbacia punctulata	Not Required	Not Required
Treatment System Sampling (Internal Outfalls)[7]	pH Quantity, Gallons	Oil and Grease TSS[1] Benzene[2]	Not Required	Not Required	Not Required	Not Required

Table J-1 Logan Airport NPDES Permit (No. MA0000787) Stormwater Outfall Monitoring Requirements (2007) (Continued)

Monitoring Event	**Northwest Outfall 005**		**Porter Outfall 003 (3 upstream locations)**		**Select Runway/Perimeter Outfalls**	
	Field Measurement	**Laboratory Analysis**	**Field Measurement**	**Laboratory Analysis**	**Field Measurement**	**Laboratory Analysis**
Monthly Dry Weather	Not Required	Not Required	Not Required	Oil and Grease TSS[1] Benzene Surfactant Fecal Coliform *Enterococcus*	Not Required	Not Required
Monthly Wet Weather	Not Required	Not Required	pH Flow Rate	Oil and Grease TSS[1] Benzene[2] Surfactant Fecal Coliform *Enterococcus*	Not Required	Not Required
Quarterly Wet Weather	pH Flow Rate[6]	Oil and Grease TSS[1] Benzene[2]	pH Flow Rate[6]	PAHs[3]: - Benzo(a)anthracene - Benzo(a)pyrene - Benzo(b)fluoranthene - Benzo(k)fluoranthene - Chrysene -Dibenzo(a,h)anthracene - Indeno(1,2,3-cd)pyrene - Naphthalene	pH	Oil and Grease TSS[1] Benzene[2]
Deicing Episode (2/Deicing Season)	Not Required	Not Required	Not Required	Ethylene Glycol Propylene Glycol BOD5[4] COD[5] Total Ammonia Nitrogen Nonylphenol Tolytriazole	Not Required	Ethylene Glycol Propylene Glycol BOD5[4] COD[5] Total Ammonia Nitrogen Nonylphenol Tolytriazole
Whole Effluent Toxicity (1st and 3rd Year Deicing Season)	Not Required	Not Required	Not Required	Menidia beryllina Arbacia punctulata	Not Required	Not Required
Treatment System Sampling (Internal Outfalls)[7]	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required

Source: Massport

Notes: Requirements are from NPDES Permit MA0000787, issued July 31, 2007.

1 TSS - Total Suspended Solids

2 Benzene must be collected with HDPE bailer.

3 PAH - Polycyclic Aromatic Hydrocarbons

4 BOD - Biological Oxygen Demand

5 COD - Chemical Oxygen Demand

6 Flow Rate will be estimated based on measured precipitation and the hydraulic model developed for the Logan Airport drainage system.

7 Outfalls 001D and 001E samples collected by Swissport.

Table J-2 Fire Training Facility NPDES Permit (No. MA0032751) Stormwater Outfall Monitoring Requirements (2014)

Monitoring Event	**Outfall Serial Number 001**	
	Field Measurement	**Laboratory Analysis**
Each Discharge Event[1]	Flow Rate[2] pH	TSS[3] Oil and Grease[4] Total BTEX[5] Toluene Benzene Ethylbenzene Xylene PAHs[5,6]
Whole Effluent Toxicity (once per year during discharge event)	Not Required	Acute Toxicity[7]

Source: Massport

Notes: Requirements are from NPDES Permit MA0032751, issued November 1, 2006.

All samples, except for wet testing, shall be collected after treatment and prior to discharge from above ground holding tank.

1 Flows from more than one training session may be held in treatment train for several weeks. Treatment and subsequent discharge through Outfall 001 is usually triggered by tank levels. Sampling will be conducted during each discharge event with the sampling point after the GAC unit and prior to discharge from the above ground holding tank. Each sample shall be a composite of three equally weighted (same volume) grab samples taken at the bottom, middle, and top of the above ground tank.

2 Total flow volume shall be reported monthly in gallons and the maximum flow rate in gallons per minute shall be reported for each month.

3 TSS - Total Suspended Solids

4 Oil and grease is measured using EPA Method 1664.

5 BTEX and PAH compounds shall be analyzed using EPA approved methods. Testing method used and method detection level for each parameter will be included in each DMR submittal.

6 PAH - Polycyclic Aromatic Hydrocarbons

7 The permittee shall conduct one acute toxicity test per year. The test results shall be submitted by the last day of the full month following completion of the test in accordance with protocols defined in the permit.

Table J-3 Logan Airport 2017 Monthly Monitoring Results for First Quarter — North, West, and Maverick Street Stormwater Outfalls

	Date	Event	Maximum Daily Flow (MGD)	Average Monthly Flow (MGD)	pH (S.U.)	Oil and Grease (mg/L)	TSS (mg/L)	Benzene (µg/L)	Surfactants (mg/L)	Fecal Coliform (cfu/100mL)	*Enterococcus* (cfu/100mL)	*Klebsiella* (cfu/100mL)
001A – North Outfall	1/23/2017	Wet Weather	4.24	0.617	7.44	<4.0	25	<1.0	0.290	34,000	350	24,000
002A – West Outfall	1/23/2017	Wet Weather	14.43	1.516	8.03	<4.0	18	<1.0	0.190	2,500	300	NA
004A – Maverick Street Outfall	1/23/2017	Wet Weather	0.966	0.079	7.04	<4.0	<5.0	<1.0	0.090	2,100	1,000	NA
001C – North Outfall	1/17/2017	Dry Weather				<4.0	12	<1.0	0.170	620	50	NA
002C – West Outfall	1/17/2017	Dry Weather				<4.0	13	<1.0	0.130	40	10	NA
004C – Maverick Street Outfall	1/17/2017	Dry Weather				<4.0	16	<1.0	0.110	50	10	NA
001A – North Outfall	2/7/2017	Wet Weather	2.59	1.16	7.40	<4.0	45	<1.0	0.360	3,900	60	NA
002A – West Outfall	2/7/2017	Wet Weather	7.314	1.326	6.79	<4.0	22	<1.0	0.290	30	<10	NA
004A – Maverick Street Outfall	2/7/2017	Wet Weather	0.215	0.045	6.81	7.3	74	<1.0	0.240	3,100	2,300	NA
001C – North Outfall	2/21/2017	Dry Weather				<4.0	21	<1.0	0.120	3,600	50	NA
002C – West Outfall	2/21/2017	Dry Weather				<4.0	16	<1.0	0.110	300	90	NA
004C – Maverick Street Outfall	2/21/2017	Dry Weather				<4.0	<5.0	<1.0	0.170	5,000	3,100	NA
001A – North Outfall	3/27/2017	Wet Weather	2.31	0.864	8.44	<4.0	18	<1.0	0.250	30	40	NA
002A – West Outfall	3/27/2017	Wet Weather	9.95	1.33	7.62	5.1	27	<1.0	0.310	280	430	NA
004A – Maverick Street Outfall	3/27/2017	Wet Weather	0.912	0.102	7.17	<4.0	54	<1.0	0.340	650	150	NA
001C – North Outfall	3/7/2017	Dry Weather				<4.0	16	<1.0	0.120	<10	50	NA
002C – West Outfall	3/7/2017	Dry Weather				<4.0	<5.0	<1.0	0.150	650	55	NA
004C – Maverick Street Outfall	3/7/2017	Dry Weather				<4.0	8.4	<1.0	0.130	3,000	450	NA
Requirements are from NPDES Permit MA0000787, issued July 31, 2007.												
Discharge Limitations												
Maximum Daily			Report	Report	6.0 to 8.5	15 mg/L	100 mg/L	Report	Report	Report	Report	
Average Monthly			Report	Report	6.0 to 8.5	—	Report	Report	Report	Report	Report	

Source: Massport.
Notes: Flow rates were estimated for outfalls 001, 002, and 004 by using the SWMM model developed for Logan Airport.
1 *Klebsiella* is an indication of non-fecal coliform bacteria and is tested for at the North Outfall when fecal coliform concentration exceeds 5,000 cfu/100ml.
NA Not Analyzed.
TSS Total Suspended Solids.

Table J-4 Logan Airport 2017 Monthly Monitoring Results for First Quarter — Porter Street Stormwater Outfall

	Date	Event	Maximum Daily Flow (MGD)	Average Monthly Flow (MGD)	pH (S.U.)	Oil and Grease (mg/L)	TSS (mg/L)	Benzene (µg/L)	Surfactants (mg/L)	Fecal Coliform (cfu/100mL)	*Enterococcus* (cfu/100mL)
003 - Porter Street Outfall 1	1/23/2017	Wet Weather	-	-	7.99	<4.0	7.8	<1.0	0.260	<10	2,400
003 - Porter Street Outfall 2	1/23/2017	Wet Weather	-	-	8.05	<4.0	20	<1.0	0.190	130	100
003 - Porter Street Outfall 3	1/23/2017	Wet Weather	-	-	7.82	<4.0	72	<1.0	0.160	<10	<10
003 - Porter Street Outfall Average		Wet Weather	2.223	0.314	7.95	0.0	33	0.0	0.203	5.1	62
003 - Porter Street Outfall 1	1/17/2017	Dry Weather				<4.0	170	<1.0	0.220	<10	10
003 - Porter Street Outfall 2	1/17/2017	Dry Weather				15	31	<1.0	0.090	10	460
003 - Porter Street Outfall 3	1/17/2017	Dry Weather				<4.0	75	<1.0	0.160	<10	20
003 - Porter Street Outfall Average		Dry Weather				5.0	92	0.0	0.157	2.2	45
003 - Porter Street Outfall 1	2/7/2017	Wet Weather	-	-	7.29	4.1	130	<1.0	0.170	160	150
003 - Porter Street Outfall 2	2/7/2017	Wet Weather	-	-	7.05	8.7	13	<1.0	0.100	<10	20
003 - Porter Street Outfall 3	2/7/2017	Wet Weather	-	-	7.51	<4.0	40	<1.0	0.120	<10	20
003 - Porter Street Outfall Average		Wet Weather	1.693	1.693	7.28	4.3	61	0.0	0.130	5.4	39
003 - Porter Street Outfall 1	2/21/2017	Dry Weather				<4.0	8	<1.0	0.250	<10	<10
003 - Porter Street Outfall 2	2/21/2017	Dry Weather				<4.0	47	<1.0	0.140	<10	40
003 - Porter Street Outfall 3	2/21/2017	Dry Weather				<4.0	6.1	<1.0	0.150	<10	<10
003 - Porter Street Outfall Average		Dry Weather				0.0	20	0.0	0.180	1.0	3.4
003 - Porter Street Outfall 1	3/27/2017	Wet Weather	-	-	7.44	<4.0	190	<1.0	0.330	290	1,000
003 - Porter Street Outfall 2	3/27/2017	Wet Weather	-	-	6.28	8.8	58	<1.0	0.220	<10	50
003 - Porter Street Outfall 3	3/27/2017	Wet Weather	-	-	5.15	5.0	230	<1.0	0.170	10	2,800
003 - Porter Street Outfall Average		Wet Weather	1.909	0.178	6.29	4.6	159	0.0	0.240	14	519
003 - Porter Street Outfall 1	3/7/2017	Dry Weather				<4.0	<5.0	<1.0	0.310	<10	<10
003 - Porter Street Outfall 2	3/7/2017	Dry Weather				<4.0	5.4	<1.0	0.810	<10	<10
003 - Porter Street Outfall 3	3/7/2017	Dry Weather				<4.0	48	<1.0	0.230	<10	<10
003 - Porter Street Outfall Average		Dry Weather				0.0	18	0.0	0.450	1.0	1.0
Requirements are from NPDES Permit MA0000787, issued July 31, 2007.											
Discharge Limitations											
Maximum Daily			Report	Report	6.0 to 8.5	Report	Report	Report	Report	Report	Report
Average Monthly			Report	Report	6.0 to 8.5	—	Report	Report	Report	Report	Report

Source: Massport.

Notes: Flow rates were estimated for outfalls 001, 002, 003 and 004 by using the SWMM model developed for Logan Airport.

For averaging calculations, a value of zero was employed for those results measured below the laboratory detection limit. For geometric mean calculations (fecal coliform and Enterococcus) a value of 1 was employed for those results measured below the laboratory detection limit.

TSS Total Suspended Solids.

NA Not Analyzed.

Table J-5 Logan Airport 2017 Monthly Monitoring Results for Second Quarter — North, West, and Maverick Street Stormwater Outfalls

	Date	Event	Maximum Daily Flow (MGD)	Average Monthly Flow (MGD)	pH (S.U.)	Oil and Grease (mg/L)	TSS (mg/L)	Benzene (µg/L)	Surfactants (mg/L)	Fecal Coliform (cfu/100mL)	*Enterococcus* (cfu/100mL)	*Klebsiella*[1] (cfu/100mL)
001A – North Outfall	4/21/2017	Wet Weather	6.54	0.773	7.08	<4.0	6.6	<1.0	0.180	70	90	NA
002A – West Outfall	4/21/2017	Wet Weather	25.5	2.496	7.28	<4.0	14	<1.0	0.330	350	200	NA
004A – Maverick Street Outfall	4/21/2017	Wet Weather	1.55	0.147	6.83	<4.0	10	<1.0	0.280	6,600	1,600	NA
001C – North Outfall	4/11/2017	Dry Weather				<4.0	25	<1.0	0.100	<10	20	NA
002C – West Outfall	4/11/2017	Dry Weather				<4.0	17	<1.0	0.100	210	200	NA
004C – Maverick Street Outfall	4/11/2017	Dry Weather				<4.0	<5.0	<1.0	0.070	180	30	NA
001A – North Outfall	5/5/2017	Wet Weather	2.94	0.343	8.42	<4.0	10	<1.0	0.130	<10	<10	NA
002A – West Outfall	5/5/2017	Wet Weather	9.48	1.122	8.48	<4.0	12	<1.0	0.100	410	410	NA
004A – Maverick Street Outfall	5/5/2017	Wet Weather	0.736	0.090	7.61	<4.0	6.3	<1.0	0.120	2,400	370	NA
001C – North Outfall	5/11/2017	Dry Weather				<4.0	11	<1.0	0.100	120	<10	NA
002C – West Outfall	5/11/2017	Dry Weather				<4.0	17	<1.0	0.090	770	180	NA
004C – Maverick Street Outfall	5/11/2017	Dry Weather				<4.0	14	<1.0	0.080	50	<10	NA
001A – North Outfall	---	Wet Weather	7.57	0.515	NS	NS	NS	NS	NS	NS	NS	NS
002A – West Outfall	---	Wet Weather	23.05	1.728	NS	NS	NS	NS	NS	NS	NS	NS
004A – Maverick Street Outfall	---	Wet Weather	1.887	0.124	NS	NS	NS	NS	NS	NS	NS	NS
001C – North Outfall	6/19/2017	Dry Weather				<4.0	10	<1.0	0.120	110	60	NA
002C – West Outfall	6/19/2017	Dry Weather				<4.0	13	<1.0	0.140	4,600	1,400	NA
004C – Maverick Street Outfall	6/19/2017	Dry Weather				<4.0	9.2	<1.0	0.120	400	200	NA
Requirements are from NPDES Permit MA0000787, issued July 31, 2007.												
Discharge Limitations												
Maximum Daily			Report	Report	6.0 to 8.5	15 mg/L	100 mg/L	Report	Report	Report	Report	
Average Monthly			Report	Report	6.0 to 8.5	—	Report	Report	Report	Report	Report	

Source: Massport.
Notes: Flow rates were estimated for outfalls 001, 002, 003 and 004 by using the SWMM model developed for Logan Airport.
1 *Klebsiella* is an indication of non-fecal coliform bacteria and is tested for at the North Outfall when fecal coliform concentration exceeds 5,000 cfu/100ml.
TSS Total Suspended Solids.
NA Not Analyzed.
NS Not Sampled. A wet weather sampling event was not conducted during the month of June 2017. During the month of June, several attempts were made to mobilize for a wet weather event based on forecasted precipitation; however, in each case, either total accumulation measured less than the required 0.1 inches, precipitation occurred outside of the low tide window or in the evening, thunderstorms were forecasted, or antecedent dry weather conditions were not met. Sampling cannot be conducted during thunderstorms due to safety concerns.

Table J-6 Logan Airport 2017 Monthly Monitoring Results for Second Quarter — Porter Street Stormwater Outfall

	Date	Event	Maximum Daily Flow (MGD)	Average Monthly Flow (MGD)	pH (S.U.)	Oil and Grease (mg/L)	TSS (mg/L)	Benzene (µg/L)	Surfactants (mg/L)	Fecal Coliform (cfu/100mL)	*Enterococcus* (cfu/100mL)
003 - Porter Street Outfall 1	4/21/2017	Wet Weather	-	-	7.46	<4.0	21	<1.0	0.180	350	640
003 - Porter Street Outfall 2	4/21/2017	Wet Weather	-	-	7.15	<4.0	7.6	<1.0	0.100	<10	20
003 - Porter Street Outfall 3	4/21/2017	Wet Weather	-	-	6.70	<4.0	<10	<1.0	0.120	10	60
003 - Porter Street Outfall Average		Wet Weather	4.66	0.505	7.10	0.0	10	0.0	0.133	15	92
003 - Porter Street Outfall 1	4/11/2017	Dry Weather				<4.0	11	<1.0	0.210	<10	20
003 - Porter Street Outfall 2	4/11/2017	Dry Weather				<4.0	32	<1.0	0.070	60	<10
003 - Porter Street Outfall 3	4/11/2017	Dry Weather				<4.0	6.1	<1.0	0.170	<10	10
003 - Porter Street Outfall Average		Dry Weather				0.0	16	0.0	0.150	3.9	5.8
003 - Porter Street Outfall 1	5/5/2017	Wet Weather	-	-	8.34	<4.0	84	<1.0	0.190	160	130
003 - Porter Street Outfall 2	5/5/2017	Wet Weather	-	-	8.46	<4.0	79	<1.0	0.160	<10	30
003 - Porter Street Outfall 3	5/5/2017	Wet Weather	-	-	7.81	<4.0	11	<1.0	0.090	80	260
003 - Porter Street Outfall Average		Wet Weather	2.101	0.217	8.20	0.0	58	0.0	0.147	23	100
003 - Porter Street Outfall 1	5/11/2017	Dry Weather				<4.0	9.8	<1.0	0.140	<10	<10
003 - Porter Street Outfall 2	5/11/2017	Dry Weather				<4.0	24	<1.0	0.130	<10	<10
003 - Porter Street Outfall 3	5/11/2017	Dry Weather				<4.0	42	<1.0	0.100	<10	<10
003 - Porter Street Outfall Average		Dry Weather				0.0	25	0.0	0.123	1.0	1.0
003 - Porter Street Outfall 1	---	Wet Weather	-	-	NS	NS	NS	NS	NS	NS	NS
003 - Porter Street Outfall 2	---	Wet Weather	-	-	NS	NS	NS	NS	NS	NS	NS
003 - Porter Street Outfall 3	---	Wet Weather	-	-	NS	NS	NS	NS	NS	NS	NS
003 - Porter Street Outfall Average		Wet Weather	4.801	0.356	NS	NS	NS	NS	NS	NS	NS
003 - Porter Street Outfall 1	6/19/2017	Dry Weather				<4.0	31	<1.0	0.280	35,000	50
003 - Porter Street Outfall 2	6/19/2017	Dry Weather				<4.0	<5.0	<1.0	0.070	240	50
003 - Porter Street Outfall 3	6/19/2017	Dry Weather				<4.0	16	<1.0	0.200	30	<10
003 - Porter Street Outfall Average		Dry Weather				0.0	16	0.0	0.183	632	14
Requirements are from NPDES Permit MA0000787, issued July 31, 2007.											
Discharge Limitations											
Maximum Daily			Report	Report	6.0 to 8.5	Report	Report	Report	Report	Report	Report
Average Monthly			Report	Report	6.0 to 8.5	—	Report	Report	Report	Report	Report

Source: Massport.
Notes: Flow rates were estimated for outfalls 001, 002, 003, and 0034 by using the SWMM model developed for Logan Airport.
For averaging calculations, a value of zero was employed for those results measured below the laboratory detection limit. For geometric mean calculations (fecal coliform and Enterococcus) a value of 1 was employed for those results measured below the laboratory detection limit.
TSS Total Suspended Solids.
NS Not Sampled. A wet weather sampling event was not conducted during the month of June 2017 due to lack of precipitation (see description in Table J-5 above).

Table J-7 Logan Airport 2017 Monthly Monitoring Results for Third Quarter — North, West, and Maverick Street Stormwater Outfalls

	Date	Event	Maximum Daily Flow (MGD)	Average Monthly Flow (MGD)	pH (S.U.)	Oil and Grease (mg/L)	TSS (mg/L)	Benzene (µg/L)	Surfactants (mg/L)	Fecal Coliform (cfu/100mL)	*Enterococcus* (cfu/100mL)	*Klebsiella*[1] (cfu/100mL)
001A – North Outfall	7/7/2017	Wet Weather	4.726	0.416	7.07	<4.0	16	<1.0	0.840	570	110	NA
002A – West Outfall	7/7/2017	Wet Weather	15.35	1.45	7.93	<4.0	16	<1.0	0.390	12,000	1,900	NA
004A – Maverick Street Outfall	7/7/2017	Wet Weather	1.21	0.077	7.16	<4.0	18	<1.0	0.220	570	3,400	NA
001C – North Outfall	7/18/2017	Dry Weather				<4.0	17	<1.0	0.150	3,500	530	NA
002C – West Outfall	7/18/2017	Dry Weather				<4.0	13	<1.0	0.120	16,000	900	NA
004C – Maverick Street Outfall	7/18/2017	Dry Weather				<4.0	10	<1.0	0.090	20	60	NA
001A – North Outfall	8/30/2017	Wet Weather	3.05	0.148	8.03	<4.0	12	<1.0	0.760	4,900	420	NA
002A – West Outfall	8/30/2017	Wet Weather	8.44	0.500	7.68	<4.0	13	<1.0	0.390	>80,000	1,700	NA
004A – Maverick Street Outfall	8/30/2017	Wet Weather	0.705	0.011	6.67	<4.0	11	<1.0	0.080	4,900	250	NA
001C – North Outfall	8/1/2017	Dry Weather				<4.0	14	<1.0	0.150	630	80	NA
002C – West Outfall	8/1/2017	Dry Weather				<4.0	13	<1.0	0.140	>80,000	1,500	NA
004C – Maverick Street Outfall	8/1/2017	Dry Weather				<4.0	10	<1.0	0.090	170	<10	NA
001A – North Outfall	9/30/2017	Wet Weather	5.28	0.367	6.79	<4.0	<5.0	<1.0	0.140	2,000	2,900	NA
002A – West Outfall	9/30/2017	Wet Weather	16.4	1.21	NS	NS	NS	NS	NS	NS	NS	NS
004A – Maverick Street Outfall	9/30/2017	Wet Weather	1.279	0.071	6.99	<4.0	<5.0	<1.0	0.140	6,300	4,500	NA
001C – North Outfall	9/11/2017	Dry Weather				<4.0	14	<1.0	0.130	140	55	NA
002C – West Outfall	9/11/2017	Dry Weather				<4.0	11	<1.0	0.220	3,700	70	NA
004C – Maverick Street Outfall	9/11/2017	Dry Weather				<4.0	11	<1.0	0.090	380	100	NA
Requirements are from NPDES Permit MA0000787, issued July 31, 2007.												
Discharge Limitations												
Maximum Daily			Report	Report	6.0 to 8.5	15 mg/L	100 mg/L	Report	Report	Report	Report	Report
Average Monthly			Report	Report	6.0 to 8.5	—	Report	Report	Report	Report	Report	Report

Source: Massport
Notes: Flow rates were estimated for outfalls 001, 002, and 004 by using the SWMM model developed for Logan Airport.
1 *Klebsiella* is an indication of non-fecal coliform bacteria and is tested for at the North Outfall when fecal coliform concentration exceeds 5,000 cfu/100ml.
TSS Total Suspended Solids.
NA Not Analyzed.
NS Not Sampled. A wet weather sample was not conducted at the West Outfall during the month of September 2017 due to outfall access restrictions.

Table J-8 Logan Airport 2017 Monthly Monitoring Results for Third Quarter — Porter Street Stormwater Outfall

	Date	Event	Maximum Daily Flow (MGD)	Average Monthly Flow (MGD)	pH (S.U.)	Oil and Grease (mg/L)	TSS (mg/L)	Benzene (µg/L)	Surfactants (mg/L)	Fecal Coliform (cfu/100mL)	*Enterococcus* (cfu/100mL)
003 - Porter Street Outfall 1	7/7/2017	Wet Weather	-	-	7.22	<4.0	240	<1.0	0.660	250	1,800
003 - Porter Street Outfall 2	7/7/2017	Wet Weather	-	-	8.05	<4.0	5.0	<1.0	0.460	50	1,700
003 - Porter Street Outfall 3	7/7/2017	Wet Weather	-	-	8.06	<4.0	8.9	<1.0	0.270	40	2,900
003 - Porter Street Outfall Average		Wet Weather	3.081	0.315	7.78	0.0	85	0.0	0.463	79	2,070
003 - Porter Street Outfall 1	7/18/2017	Dry Weather				<4.0	13	<1.0	0.130	210	90
003 - Porter Street Outfall 2	7/18/2017	Dry Weather				<4.0	5.6	<1.0	0.070	30	<10
003 - Porter Street Outfall 3	7/18/2017	Dry Weather				<4.0	<5.0	<1.0	0.200	40	20
003 - Porter Street Outfall Average		Dry Weather				0.0	6.2	0.0	0.133	63	12
003 - Porter Street Outfall 1	8/30/2017	Wet Weather	-	-	7.70	<4.0	59	<1.0	0.270	620	250
003 - Porter Street Outfall 2	8/30/2017	Wet Weather	-	-	8.28	<4.0	<5.0	<1.0	0.120	6,300	80
003 - Porter Street Outfall 3	8/30/2017	Wet Weather	-	-	7.27	<4.0	6.1	<1.0	0.200	280	2,400
003 - Porter Street Outfall Average		Wet Weather	0.926	0.106	7.75	0.0	22	0.00	0.197	1,030	363
003 - Porter Street Outfall 1	8/1/2017	Dry Weather				<4.0	47	<1.0	0.120	910	110
003 - Porter Street Outfall 2	8/1/2017	Dry Weather				<4.0	5.4	<1.0	0.070	<10	40
003 - Porter Street Outfall 3	8/1/2017	Dry Weather				<4.0	5.1	<1.0	0.140	<10	60
003 - Porter Street Outfall Average		Dry Weather				0.0	19	0.0	0.110	10	64
003 - Porter Street Outfall 1	9/30/2017	Wet Weather	-	-	7.28	<4.0	11	<1.0	0.140	1,100	170,000
003 - Porter Street Outfall 2	9/30/2017	Wet Weather	-	-	7.19	<4.0	<5.0	<1.0	0.080	20	10
003 - Porter Street Outfall 3	9/30/2017	Wet Weather	-	-	6.90	<4.0	<5.0	<1.0	0.140	390	230
003 - Porter Street Outfall Average		Wet Weather	2.216	0.206	7.12	0.0	3.7	0.00	0.120	205	726
003 - Porter Street Outfall 1	9/11/2017	Dry Weather				<4.0	26	<1.0	0.100	170	70
003 - Porter Street Outfall 2	9/11/2017	Dry Weather				<4.0	11	<1.0	0.080	50	80
003 - Porter Street Outfall 3	9/11/2017	Dry Weather				<4.0	6.7	<1.0	0.210	260	490
003 - Porter Street Outfall Average		Dry Weather				0.0	15	0.0	0.130	130	140
Requirements are from NPDES Permit MA0000787, issued July 31, 2007.											
Discharge Limitations											
Maximum Daily			Report	Report	6.0 to 8.5	Report	Report	Report	Report	Report	Report
Average Monthly			Report	Report	6.0 to 8.5	—	Report	Report	Report	Report	Report

Source: Massport.
Notes: Flow rates were estimated for outfall 003 by using the SWMM model developed for Logan Airport.
For averaging calculations, a value of zero was employed for those results measured below the laboratory detection limit. For geometric mean calculations (fecal coliform and Enterococcus) a value of 1 was employed for those results measured below the laboratory detection limit.
TSS Total Suspended Solids.

Table J-9 Logan Airport 2017 Monthly Monitoring Results for Fourth Quarter — North, West, and Maverick Street Stormwater Outfalls

	Date	Event	Maximum Daily Flow (MGD)	Average Monthly Flow (MGD)	pH (S.U.)	Oil and Grease (mg/L)	TSS (mg/L)	Benzene (µg/L)	Surfactants (mg/L)	Fecal Coliform (cfu/100mL)	*Enterococcus* (cfu/100mL)	*Klebsiella*[1] (cfu/100mL)
001A – North Outfall	10/25/2017	Wet Weather	4.545	0.440	7.31	<4.0	<5.0	<1.0	0.090	1,100	13,000	NA
002A – West Outfall	10/25/2017	Wet Weather	20.13	1.61	8.50	<4.0	29	<1.0	0.150	41,000	25,000	NA
004A – Maverick Street Outfall	10/25/2017	Wet Weather	1.067	0.091	7.73	<4.0	11	<1.0	0.110	7,500	20,000	NA
001C – North Outfall	10/6/2017	Dry Weather				<4.0	23	<1.0	0.150	800	50	NA
002C – West Outfall	10/6/2017	Dry Weather				<4.0	8.7	<10	0.110	3,400	900	NA
004C – Maverick Street Outfall	10/6/2017	Dry Weather				<4.0	7.7	<1.0	0.070	2,200	140	NA
001A – North Outfall	11/22/2017	Wet Weather	2.82	0.172	7.23	<4.0	30.0	<1.0	0.180	60	400	NA
002A – West Outfall	11/22/2017	Wet Weather	9.94	0.632	7.13	<4.0	17	<1.0	0.220	1,700	1,700	NA
004A – Maverick Street Outfall	11/22/2017	Wet Weather	0.789	0.024	7.36	<4.0	25	<1.0	0.180	1,400	1,600	NA
001C – North Outfall	11/13/2017	Dry Weather				<4.0	20	<1.0	0.160	<10	20	NA
002C – West Outfall	11/13/2017	Dry Weather				<4.0	13	<1.0	0.150	20,000	310	NA
004C – Maverick Street Outfall	11/13/2016	Dry Weather				<4.0	10	<1.0	0.090	1,900	160	NA
001A – North Outfall	12/6/2017	Wet Weather	1.76	0.510	6.16	<4.0	<5.0	<1.0	0.100	290	5,000	NA
002A – West Outfall	12/6/2017	Wet Weather	5.87	0.823	7.45	<4.0	12	<1.0	0.100	5,800	7,300	NA
004A – Maverick Street Outfall	12/6/2017	Wet Weather	0.453	0.008	6.79	<4.0	8.5	<1.0	0.090	700	830	NA
001C – North Outfall	12/5/2017	Dry Weather				<4.0	9.5	<1.0	0.120	60	10	NA
002C – West Outfall	12/5/2017	Dry Weather				<4.0	11	<1.0	0.160	>80,000	30,000	NA
004C – Maverick Street Outfall	12/5/2017	Dry Weather				<4.0	54	<1.0	0.060	630	100	NA
Requirements are from NPDES Permit MA0000787, issued July 31, 2007.												
Discharge Limitations												
Maximum Daily			Report	Report	6.0 to 8.5	15 mg/L	100 mg/L	Report	Report	Report	Report	Report
Average Monthly			Report	Report	6.0 to 8.5	—	Report	Report	Report	Report	Report	Report

Source: Massport.
Notes: Flow rates were estimated for outfalls 001, 002, and 004 by using the SWMM model developed for Logan Airport.
1 *Klebsiella* is an indication of non-fecal coliform bacteria and is tested for at the North Outfall when fecal coliform concentration exceeds 5,000 cfu/100ml.
TSS Total Suspended Solids.
NA Not Analyzed.

Table J-10 Logan Airport 2017 Monthly Monitoring Results for Fourth Quarter — Porter Street Stormwater Outfall

	Date	Event	Maximum Daily Flow (MGD)	Average Monthly Flow (MGD)	pH (S.U.)	Oil and Grease (mg/L)	TSS (mg/L)	Benzene (µg/L)	Surfactants (mg/L)	Fecal Coliform (cfu/100mL)	*Enterococcus* (cfu/100mL)
003 - Porter Street Outfall 1	10/25/2017	Wet Weather	-	-	7.79	<4.0	12	<1.0	0.110	6,400	18,000
003 - Porter Street Outfall 2	10/25/2017	Wet Weather	-	-	7.76	<4.0	<5.0	<1.0	0.070	120	460
003 - Porter Street Outfall 3	10/25/2017	Wet Weather	-	-	8.04	<4.0	<5.0	<1.0	0.080	670	4,700
003 - Porter Street Outfall Average		Wet Weather	4.339	0.352	7.86	0.0	4.0	0.0	0.087	801	3389
003 - Porter Street Outfall 1	10/6/2017	Dry Weather				< 4.0	16	< 1.0	0.120	<10	320
003 - Porter Street Outfall 2	10/6/2017	Dry Weather				< 4.0	<5.0	< 1.0	0.070	30	10
003 - Porter Street Outfall 3	10/6/2017	Dry Weather				< 4.0	<5.0	< 1.0	0.180	20	2,200
003 - Porter Street Outfall Average		Dry Weather				0.0	5.3	0.0	0.123	8.4	192
003 - Porter Street Outfall 1	11/22/2017	Wet Weather	-	-	7.00	<4.0	28	<1.0	0.120	80	1,900
003 - Porter Street Outfall 2	11/22/2017	Wet Weather	-	-	6.21	<4.0	25	<1.0	0.060	<10	100
003 - Porter Street Outfall 3	11/22/2017	Wet Weather	-	-	6.16	<4.0	6.6	<1.0	<0.050	160	900
003 - Porter Street Outfall Average		Wet Weather	1.838	0.152	6.46	0.0	20	0.0	0.060	23	555
003 - Porter Street Outfall 1	11/22/2017	Dry Weather				<4.0	8.8	<1.0	0.110	20	60
003 - Porter Street Outfall 2	11/22/2017	Dry Weather				<4.0	8.3	<1.0	0.250	<10	<10
003 - Porter Street Outfall 3	11/22/2017	Dry Weather				<4.0	8.2	<1.0	0.210	<10	50
003 - Porter Street Outfall Average		Dry Weather				0.0	8.4	0.0	0.190	2.7	14
003 - Porter Street Outfall 1	12/6/2017	Wet Weather	-	-	7.76	<4.0	12	<1.0	0.080	120	780
003 - Porter Street Outfall 2	12/6/2017	Wet Weather	-	-	7.66	<4.0	5.5	<1.0	0.090	20	420
003 - Porter Street Outfall 3	12/6/2017	Wet Weather	-	-	7.80	<4.0	<5.0	<1.0	0.160	<10	100
003 - Porter Street Outfall Average		Wet Weather	1.301	0.149	7.74	0.0	5.8	0.0	0.110	13	320
003 - Porter Street Outfall 1	12/5/2017	Dry Weather				4.3	130	<1.0	<0.250	10	170
003 - Porter Street Outfall 2	12/5/2017	Dry Weather				<4.0	21	<1.0	0.200	40	480
003 - Porter Street Outfall 3	12/5/2017	Dry Weather				<4.0	12	<1.0	0.190	<10	70
003 - Porter Street Outfall Average		Dry Weather				1.4	54	0.0	0.130	7.4	179
Requirements are from NPDES Permit MA0000787, issued July 31, 2007.											
Discharge Limitations											
Maximum Daily			Report	Report	6.0 to 8.5	Report	Report	Report	Report	Report	Report
Average Monthly			Report	Report	6.0 to 8.5	—	Report	Report	Report	Report	Report

Source: Massport.

Notes: Flow rates were estimated for outfall 003 using the SWMM model developed for Logan Airport.
For averaging calculations, a value of zero was employed for those results measured below the laboratory detection limit. For geometric mean calculations (fecal coliform and Enterococcus) a value of 1 was employed for those results measured below the laboratory detection limit.

Table J-11 Logan Airport 2017 Quarterly Wet Weather Monitoring Results – North, West, Maverick Street, and Porter Street Stormwater Outfalls

	Date	pH (S.U.)	Benzo(a)-anthracene (µg/L)	Benzo(a)-pyrene (µg/L)	Benzo(b)-fluoranthene (µg/L)	Benzo(k)-fluoranthene (µg/L)	Chrysene (µg/L)	Dibenzo(a,h,)-anthracene (µg/L)	Indeno(1,2,3-cd)-pyrene (µg/L)	Naphthalene (µg/L)	Total PAHs (µg/L)
001Q - North Outfall	3/10/2017	6.86	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	ND
002Q - West Outfall	3/10/2017	7.37	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	ND
004Q - Maverick Street Outfall	3/10/2017	6.89	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	ND
003Q - Porter Street Outfall 1	3/10/2017	7.01	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	ND
003Q - Porter Street Outfall 2	3/10/2017	7.69	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	ND
003Q - Porter Street Outfall 3	3/10/2017	7.27	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	ND
003Q - Porter Street Outfall Average		7.32	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
001Q - North Outfall	7/7/2017	7.07	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	ND
002Q - West Outfall	7/7/2017	7.93	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	ND
004Q - Maverick Street Outfall	7/7/2017	7.16	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	ND
003Q - Porter Street Outfall 1	7/7/2017	7.22	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	ND
003Q - Porter Street Outfall 2	7/7/2017	8.05	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	ND
003Q - Porter Street Outfall 3	7/7/2017	8.06	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	ND
003Q - Porter Street Outfall Average		7.78	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
001Q - North Outfall	9/30/2017	6.79	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	ND
002Q - West Outfall	9/30/2017	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
004Q - Maverick Street Outfall	9/30/2017	6.99	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	ND
003Q - Porter Street Outfall 1	9/30/2017	7.28	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	ND
003Q - Porter Street Outfall 2	9/30/2017	7.19	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	ND
003Q - Porter Street Outfall 3	9/30/2017	6.90	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	ND
003Q - Porter Street Outfall Average		7.12	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
001Q - North Outfall	12/6/2017	6.16	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	ND
002Q - West Outfall	12/6/2017	7.45	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	ND
004Q - Maverick Street Outfall	12/6/2017	6.79	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	ND
003Q - Porter Street Outfall 1	12/6/2017	7.76	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	ND
003Q - Porter Street Outfall 2	12/6/2017	7.66	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	ND
003Q - Porter Street Outfall 3	12/6/2017	7.80	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	ND
003Q - Porter Street Outfall Average		7.74	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Requirements are from NPDES Permit MA0000787, issued July 31, 2007.											
Discharge Limitations											
Maximum Daily		6.0 to 8.5	Report	Report	Report	Report	Report	Report	Report	Report	Total

Source: Massport
Notes: For averaging calculations, a value of zero was employed for those results measures below the laboratory detection limit.
PAHs Polynuclear Aromatic Hydrocarbons
ND Not Detected
TSS Total Suspended Solids.
NS Not Sampled. A wet weather sample was not conducted at the West Outfall during the month of September 2017 due to outfall access restrictions.

Table J-12 Logan Airport 2017 Quarterly Wet Weather Monitoring Results – Northwest and Runway/Perimeter Stormwater Outfalls

	Date	Maximum Daily Flow (MGD)	Average Monthly Flow (MGD)	pH (SU)	Oil and Grease (mg/L)	TSS (mg/L)	Benzene (µg/L)
005Q - Northwest Outfall	3/10/2017	0.29	0.05	6.74	<4.0	18	<1.0
006Q- Runway/ Perimeter Outfall (A9)	3/10/2017	0.17	0.05	7.57	<4.0	11	<1.0
006Q- Runway/ Perimeter Outfall (A15)	3/10/2017	0.06	0.01	8.83	<4.0	400	<1.0
006Q- Runway/ Perimeter Outfall (A19)	3/10/2017	0.04	0.005	7.61	<4.0	170	<1.0
006Q- Runway/ Perimeter Outfall (A21)	3/10/2017	1.06	0.30	7.61	<4.0	9.6	<1.0
006Q- Runway/ Perimeter Outfall (A23)	3/10/2017	0.15	0.03	8.06	<4.0	12	<1.0
006Q- Runway/ Perimeter Outfall (A34)	3/10/2017	0.30	0.12	8.51	<4.0	13	<1.0
006Q- Runway/ Perimeter Outfall (A38)	3/10/2017	0.14	0.04	8.12	<4.0	<5.0	<1.0
006- Runway/Perimeter Outfall Average		0.27	0.08	8.04	0.0	88	0.0
005Q - Northwest Outfall	7/7/2017	1.03	0.07	6.92	<4.0	26	<1.0
006Q- Runway/ Perimeter Outfall (A8)	7/7/2017	0.60	0.04	7.15	<4.0	<5.0	<1.0
006Q- Runway/ Perimeter Outfall (A21)	7/7/2017	4.32	0.34	7.16	<4.0	42	<1.0
006Q- Runway/ Perimeter Outfall (A22)	7/7/2017	2.17	0.16	7.10	<4.4	13	<1.0
006Q- Runway/ Perimeter Outfall (A23)	7/7/2017	0.34	0.03	7.06	<4.0	8.0	<1.0
006Q- Runway/ Perimeter Outfall (A31)	7/7/2017	0.40	0.27	7.18	<4.0	20	<1.0
006Q- Runway/ Perimeter Outfall (A33)	7/7/2017	0.20	0.03	7.19	<4.0	9.5	<1.0
006Q- Runway/ Perimeter Outfall (A38)	7/7/2017	0.70	0.05	6.83	<4.0	<5.0	<1.0
006- Runway/Perimeter Outfall Average		1.25	0.13	7.10	0.0	13	0.0
005Q - Northwest Outfall	9/30/2017	0.70	0.05	7.02	<4.0	58	<1.0
006Q- Runway/ Perimeter Outfall (A9)	9/30/2017	0.31	0.023	6.81	<4.0	6.0	<1.0
006Q- Runway/ Perimeter Outfall (A16)	9/30/2017	0.14	0.009	6.06	<4.0	<5.0	<1.0
006Q- Runway/ Perimeter Outfall (A18)	9/30/2017	0.04	0.003	6.77	<4.0	<5.0	<1.0
006Q- Runway/ Perimeter Outfall (A21)	9/30/2017	2.96	0.173	6.90	<4.0	9.0	<1.0
006Q- Runway/ Perimeter Outfall (A23)	9/30/2017	0.24	0.018	6.53	<4.0	<5.0	<1.0
006Q- Runway/ Perimeter Outfall (A33)	9/30/2017	0.16	0.013	6.36	<4.0	5.7	<1.0
006- Runway/Perimeter Outfall Average		0.61	0.037	6.61	0.0	110	0.0
005Q - Northwest Outfall	12/6/2017	0.216	0.022	NS	NS	NS	NS
006Q- Runway/ Perimeter Outfall (A8)	12/6/2017	0.096	0.015	7.24	<4.0	<5.0	<1.0
006Q- Runway/ Perimeter Outfall (A16)	12/6/2017	0.038	0.006	NS	NS	NS	NS
006Q- Runway/ Perimeter Outfall (A18)	12/6/2017	0.019	0.003	NS	NS	NS	NS
006Q- Runway/ Perimeter Outfall (A21)	12/6/2017	0.778	0.111	NS	NS	NS	NS
006Q- Runway/ Perimeter Outfall (A23)	12/6/2017	0.092	0.014	NS	NS	<5.0	NS
006Q- Runway/ Perimeter Outfall (A33)	12/6/2017	0.080	0.014	NS	NS	NS	NS
006Q- Runway/ Perimeter Outfall (A38)	12/6/2017	0.090	0.012	NS	NS	NS	NS
006- Runway/Perimeter Outfall Average		0.170	0.025	7.24	0.0	0.0	0.0
Discharge Limitations		Report	Report	Report	Report	Report	Report

Source: Massport

Notes: For averaging calculations, a value of zero was employed for those results measures below the laboratory detection limit.
Requirements are from NPDES Permit MA 0000787, issued July 31, 2007.

TSS Total Suspended Solids

NS Not Sampled. A wet weather sample was not conducted at the Northwest Outfall and nearly all of the Runway/Perimeter Outfalls during the month of December 2017 due to insufficient outfall flow.

Table J-13 Logan Airport February 2017 Wet Weather Deicing Monitoring Results – North, West, Porter Street, and Runway/Perimeter Stormwater Outfalls

	Date	Ethylene Glycol, Total (mg/L)	Propylene Glycol, Total (mg/L)	BOD5 (mg/L)	COD (mg/L)	Ammonia Nitrogen (mg/L)	Nonylphenol (µg/L)	4-Methyl-1-H-benzotriazole (µg/L)	5-Methyl-1-H-benzotriazole (µg/L)	Tolytriazole (µg/L)
001B - North Outfall	2/1/2017	<10.0	297	2,500	830	2.56	<0.020	37.86	38.36	76.22
002B - West Outfall	2/1/2017	<50.0	1,850	1,900	5,000	1.68	<0.020	18.93	10.12	29.05
003B - Porter Street Outfall 1	2/1/2017	<10.0	93.5	24	190	1.76	<0.020	1.15	0.96 J	2.11
003B - Porter Street Outfall 2	2/1/2017	<2.0	67.7	290	560	0.172	<0.020	<1.00	<1.00	ND
003B - Porter Street Outfall 3	2/1/2017	<2.0	20.6	30	260	1.06	<0.020	<1.00	0.57 J	0.57 J
003B - Porter Street Outfall Average		0.0	61	115	337	1.00	0.0	0.38	0.51	0.89
006B- Runway/ Perimeter (A8)	2/1/2017	<2.0	5.37	<2.0	47	0.787	<0.020	1.57	0.26 J	1.83
006B- Runway/ Perimeter (A21)	2/1/2017	<2.0	<2.0	2.1	63	1.61	<0.020	6.41	1.17	7.58
006B- Runway/ Perimeter (A22)	2/1/2017	<2.0	<2.0	<5.0	<20	3.12	<0.020	8.31	1.93	10.24
006B- Runway/ Perimeter (A23)	2/1/2017	<2.0	<2.0	2.2	45	1.76	<0.020	9.35	1.39	10.74
006B- Runway/ Perimeter (A31)	2/1/2017	<2.0	14.7	42	72	3.88	<0.020	13.79	4.43	18.22
006B- Runway/ Perimeter (A34)	2/1/2017	<2.0	<2.0	2.8	54	3.35	<0.020	11.67	2.59	14.26
006B- Runway/ Perimeter (A38)	2/1/2017	<2.0	<2.0	<2.0	47	0.286	<0.020	<1.00	<1.00	0.00
006B- Runway/Perimeter Outfall Average		0.00	2.9	7.0	47	2.11	0.0	7.30	1.68	8.98
Requirements are from NPDES Permit MA0000787, issued July 31, 2007.										
Discharge Limitations										
Average Monthly		Report	Report	Report	Report	Report	Report	Report	Report	Report
Maximum Daily		Report	Report	Report	Report	Report	Report	Report	Report	Report

Source: Massport

Notes: For averaging calculations, a value of zero was employed for those results measured below the laboratory detection limit.
J = value is an estimate calculated by the lab from the response factors of the other two triazole compounds.
Tolytriazole concentrations calculated as sum of 4-Methly-1-H-benzotriazole and 5-Methyl-1-H-benzotriazole.

BOD5 Five-day Biochemical Oxygen Demand
COD Chemical Oxygen Demand
ND Not Detected

Table J-14 Logan Airport March 2017 Wet Weather Deicing Monitoring Results – North, West, Porter Street, and Runway/Perimeter Stormwater Outfalls

	Date	Ethylene Glycol, Total (mg/L)	Propylene Glycol, Total (mg/L)	BOD5 (mg/L)	COD (mg/L)	Ammonia Nitrogen (mg/L)	Nonylphenol (µg/L)	4-Methyl-1-H-benzotriazole (µg/L)	5-Methyl-1-H-benzotriazole (µg/L)	Tolytriazole (µg/L)
001B - North Outfall	3/10/2017	5.10	3,730	3,500	7,300	1.99	<0.020	63.72	55.58	119.30
002B - West Outfall	3/10/2017	<2.0	9,940	8,200	20,000	1.46	4.163	17.66	19.11	36.77
003B - Porter Street Outfall 1	3/10/2017	<2.0	3.88	7.8	440	1.91	<0.020	2.01	1.73	3.74
003B - Porter Street Outfall 2	3/10/2017	<2.0	20.9	45	140	0.15	<0.020	25.07	14.85	39.92
003B - Porter Street Outfall 3	3/10/2017	<2.0	4.34	24	110	0.15	<0.020	<1.0	<1.00	ND
003B - Porter Street Outfall Average		0.0	10	26	230	0.74	0.0	9.03	5.53	14.6
006B- Runway/ Perimeter (A9)	3/10/2017	<2.0	2.80	<40	170	0.341	<0.020	<1.00	2.48	2.48
006B- Runway/ Perimeter (A15)	3/10/2017	<2.0	<2.0	21	77	3.22	<0.020	<1.00	8.22	8.22
006B- Runway/ Perimeter (A19)	3/10/2017	<2.0	<2.0	13	500	5.39	<0.020	4.74	14.14	18.88
006B- Runway/ Perimeter (A21)	3/10/2017	<2.0	16.8	33	570	1.56	<0.020	1.76	6.77	8.53
006B- Runway/ Perimeter (A23)	3/10/2017	<2.0	<2.0	9.8	220	2.31	<0.020	2.41	11.86	14.27
006B- Runway/ Perimeter (A34)	3/10/2017	<2.0	4.27	19	110	3.10	<0.020	3.43	11.44	14.87
006B- Runway/ Perimeter (A38)	3/10/2017	<2.0	<2.0	<2.0	120	0.314	<0.020	<1.00	<1.00	ND
006B- Runway/Perimeter Outfall Average		0.00	3.41	14	252	2.32	0.0	1.76	7.84	9.61
Requirements are from NPDES Permit MA0000787, issued July 31, 2007.										
Discharge Limitations										
Average Monthly		Report	Report	Report	Report	Report	Report	Report	Report	Report
Maximum Daily		Report	Report	Report	Report	Report	Report	Report	Report	Report

Source: Massport.
Notes: For averaging calculations, a value of zero was employed for those results measured below the laboratory detection limit.
Tolytriazole concentrations calculated as sum of 4-Methly-1-H-benzotriazole and 5-Methyl-1-H-benzotriazole.
BOD5 Five-day Biochemical Oxygen Demand
COD Chemical Oxygen Demand
ND Not Detected

Table J-15 Logan Airport Stormwater Outfall NPDES Water Quality Monitoring Results – 1993 to 2017

	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
# / # = Number of samples at or below NPDES limits / Total number of samples taken[1]																									
Oil and Grease (mg/L)																									
North Outfall	30/31	35/36	33/35	29/35	30/35	35/36	29/30	34/36	28/28	36/36	30/32	32/34	33/35	33/33	29/29	23/23	24/24	24/24	24/24	21/21	20/20	21/21	19/20	23/23	23/23
West Outfall	29/30	36/36	34/34	36/36	34/35	36/36	30/30	35/35	27/28	36/36	31/32	33/34	35/35	32/33	28/28	22/23	24/24	24/24	22/24	21/21	21/21	21/21	19/19	23/23	22/22
Maverick Street Outfall	29/29	36/36	35/35	36/36	35/35	35/36	30/30	34/34	26/28	35/36	32/32	34/34	35/35	32/33	29/29	22/23	20/21	19/19	23/23	15/15	4/4	20/20	18/18	23/23	23/23
Settable Solids[2] (mg/L)																									
North Outfall	19/19	34/35	34/35	32/35	31/34	34/36	30/30	34/36	29/29	32/36	32/32	34/34	33/35	32/34	22/22	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
West Outfall	19/19	32/36	34/34	35/36	34/34	35/36	29/30	36/36	27/28	36/36	31/32	34/34	32/35	33/33	22/22	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
TSS (mg/L)																									
North Outfall	-	-	-	-	-	-	-	-	-	-	-	-	-	-	6/6	24/24	24/24	22/23	24/24	21/21	20/21	21/21	20/20	23/23	23/23
West Outfall	-	-	-	-	-	-	-	-	-	-	-	-	-	-	5/6	24/24	24/24	23/23	22/24	20/22	21/21	20/21	18/19	23/23	22/22
Maverick Street Outfall	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4/6	22/24	20/21	18/19	20/23	14/15	4/4	19/20	18/18	22/23	23/23
pH																									
North Outfall	34/35	33/36	35/35	35/35	35/35	36/36	30/30	36/36	29/29	36/36	32/32	34/34	35/35	34/34	26/26	12/12	16/16	11/11	12/12	9/9	8/8	8/8	8/8	10/11	8/8
West Outfall	34/34	28/36	33/34	35/36	35/35	36/36	30/30	36/36	29/29	36/36	32/32	34/34	35/35	33/33	26/26	12/12	16/16	11/11	12/12	9/9	9/9	8/8	8/8	11/11	7/7
Porter Street Outfall	35/35	30/36	34/34	36/36	35/35	36/36	30/30	36/36	28/28	36/36	32/32	34/34	35/35	33/33	22/22	21/21	48/48	24/24	23/23	26/27	24/27	24/24	19/23	33/33	33/33
Maverick Street Outfall	35/35	35/36	35/35	36/36	34/35	36/36	30/30	35/35	28/28	36/36	32/32	34/34	35/35	33/33	26/26	10/10	16/16	10/10	11/11	6/6	2/2	7/7	7/7	10/11	8/8

Source: Massport

Notes: Sampling requirements changed in 2007 with the issuance of a new NPDES permit. Results through 2007 are based on NPDES Permit MA0000787, issued March 1, 1978. Stormwater outfall water quality monitoring results collected in accordance with the requirements of former NPDES permit. A portion of the Porter Street Drainage Area was incorporated into the West Drainage Area as part of roadway construction projects at Logan Airport.

N/A Not available.

1 The total number of samples at each outfall varies year to year. In some years, fewer samples are taken due to factors such as construction, weather, and/or tidal conditions.

2 Settleable solids analyses were replaced with TSS in 2008.

Table J-16 Logan Airport Oil and Hazardous Material Spills[1] and Jet Fuel Handling – 1990 to 2017

Year	Total Number of all Spills	Total Number of all Spills >10 gallons	Total Volume of all Spills (Gallons)	Estimated Volume of Jet Fuel Handled (Gallons)	Total Volume of Jet Fuel Spilled (Gallons)
1990	173	N/A	N/A	438,100,000	3,745
1991	186	N/A	N/A	N/A	2,471
1992	195	N/A	N/A	N/A	4,355
1993	188	N/A	N/A	451,900,000	3,131
1994	217	N/A	N/A	476,700,000	4,046
1995	161	N/A	N/A	309,200,000	21,412[2]
1996	159	N/A	N/A	346,700,000	1,321
1997	147	N/A	N/A	377,488,161	2,029[3]
1998	191	N/A	N/A	387,224,004	10,047[4]
1999	196	43	7,151	425,937,051	7,012[5]
2000	136	20	1,318	441,901,932	1,227
2001	139	37	1,924	416,748,819	1,771
2002	101	16	653	358,190,362	559
2003	128	19	10,364	319,439,910	10,188[6]
2004	126	18	894	373,996,141	574
2005	97	15	2,319	368,645,932	585
2006	92	11	752	364,450,864	644
2007	108	7	604	367,585,187	361
2008	99	20	944	345,631,788	662
2009	95	6	1004	327,358,619	915
2010	87	15	476	335,693,997	360
2011	108	12	572	340,421,373	337
2012	132	5	593	343,731,127	439
2013	94	6	452	349,397,940	351
2014	129	17	2,785	370,222,342	785
2015	196	16	1,278	374,985,216	885
2016	231	14	1,158	456,003,328	558
2017	176	8	2,310[7]	472,229,047	315

Source: Massport Fire-Rescue Department.

Notes:

N/A Not available.

1 Materials include: jet fuel, hydraulic oil, diesel fuel, gasoline, and other materials such as glycol and paint.

2 One tenant spill, which occurred on October 15, 1995, totaled 18,000 gallons (84 percent of the annual spill total). The spill did not enter the Airport's storm drain system.

3 On October 23, 1997, a fuel line on an aircraft failed, resulting in the release of approximately 2,500 gallons, all but 60 gallons of which were recovered in drums before reaching the ground. Only the 60 gallons is included in the 1997 total.

4 Includes a 7,200-gallon spill that was discovered on September 2, 1998, and a 1,300-gallon spill that occurred on June 3, 1998. Neither spill entered the Airport's storm drain system.

5 Includes a 5,000-gallon spill, none of which entered the Airport's storm drainage system.

6 In 2003, one fuel spill comprised 9,460 gallons or 94 percent of the total volume of the MassDEP/MCP reportable spills that year. The fuel spill was contained and did not enter the drainage system.

7 Includes 1,750 gallons of deicing fluid.

Table J-17 Type and Quantity of Oil and Hazardous Material Spills at Logan Airport – 1999 to 2017

	Jet Fuel			Hydraulic Oil			Diesel Fuel			Gasoline			Other		
Year	No. of Spills	Quantity (Gallons)	No. of Spills ≥ 10 Gallons	No. of Spills	Quantity (Gallons)	No. of Spills ≥ 10 Gallons	No. of Spills	Quantity (Gallons)	No. of Spills ≥ 10 Gallons	No. of Spills	Quantity (Gallons)	No. of Spills ≥ 10 Gallons	No. of Spills	Quantity (Gallons)	No. of Spills ≥ 10 Gallons
1999	151	7,012	40	24	67	1	13	49	2	5	7	0	3	16	0
2000	115	1,227	18	8	59	2	3	11	0	8	16	0	2	5	0
2001	104	1,771	32	21	92	3	5	30	1	6	26	1	3	5	0
2002	79	559	15	7	38	0	8	37	18	4	8	0	3	11	0
2003	89	10,188	15	15	91	3	15	30	0	7	24	0	2	31	1
2004	82	574	12	17	189	4	14	52	0	7	26	0	6[1]	53[2]	2[3]
2005	66	585	12	14	78	1	7	1,610	2	7	45	0	3[4]	1	0
2006	65	644	9	10	25	0	6	57	1	4	9	0	7	17	1
2007	66	361	4	16	37	0	16	57	1	3	8	0	7	141[5]	2
2008	74	662	19	15	56	2	5	14	0	1	7	0	4	205[6]	1
2009	95	915	6	21	51	0	9	20	0	3	3	0	11	15	0
2010	54	360	12	17	50	1	5	56	2	2	3	0	7	7	0
2011	69	337	10	21	149	1	7	55	1	4	16	0	7	15	0
2012	80	439	4	25	79	1	17	38	0	2	12	0	8	25	0
2013	56	351	5	15	51	0	13	32	0	2	<2	0	7	10	0
2014	81	785	13	24	98	1	17	1,810	2	4	9	0	3	83	1
2015	110	885	10	43	149	3	16	151	2	7	46	1	20	47	0
2016	94	558	8	73	224	4	30	300	2	6	12	0	28	64	0
2017	103	315	5	36	101	1	13	59	2	4	14	0	20	1,821[7]	0

Source: Massport
1 Includes two Unknown spills (14 gallons), plus one spill of each of the following: Ethylene Glycol, Propylene Glycol, AVGAS, and Paint.
2 Ethylene Glycol (25 gallons), Propylene Glycol (10 gallons), AVGAS (1 gallon) and Paint (3 gallons).
3 One spill of Ethylene Glycol; one spill of Propylene Glycol.
4 Includes two spills of an unknown substance and volume.
5 Includes one spill of motor oil (4 gallons); one spill of kerosene (5 gallons); one spill of cooking oil (120 gallons); one spill of fuel oil (10 gallons); one spill from a battery (1 gallon); two spills of an unknown substance (1 gallon).
6 Includes one spill of transformer oil (200 gallons).
7 Includes 1,750 gallons of deicing fluid (vehicle accident).

Table J-18 Massport Contingency Plan (MCP) Closed Sites at Logan Airport

Location (RTN) and MassDEP Reporting Status	Action/Status
1. North Outfall (3-4837) – CLOSED 12/27/2012	
Phase II and Phase III Reports filed in March 1997	Indicated petroleum contamination present at the site was likely the result of decades of airport operation; risk assessment reported no significant risk to human health, or to the aquatic and avian community.
RAO submitted in March 1998	Class C RAO using a Temporary Solution (periodic site monitoring and assessment); remediation steps included (not limited to) installation of a new fuel distribution system and decommissioning of certain fuel lines, and natural biodegradation processes; goal is to have petroleum contamination reduced to an area less than 1,000 square feet. Installation of the new fuel distribution system and decommissioning of sections of the old system were completed. Massport initiated site evaluation to document the reduction of petroleum contamination following the decommissioning of the North Fuel Farm and fuel distribution system.
Post Class C RAO evaluation report submitted in December 2002	Massport has eliminated substantial hazards at this site and submitted a Class C RAO statement. In accordance with applicable regulations, Massport will conduct a periodic evaluation at five-year intervals until a Permanent Solution has been achieved. The next periodic evaluation was scheduled for 2007.
2004	Evaluation report indicated that a "Condition of No Significant Risk" has not been achieved at this site. Massport scheduled another assessment in 2007.
2005	No change in status for 2005.
2006	Massport prepared the five-year review of the Class C RAO for this site, which was due in December 2007.
2007	Massport completed its five-year review of the Class C RAO and transmitted it to MassDEP in December 2007. It was determined that a "Condition of No Significant Risk" has not been achieved at this site at this time. The next five-year re-evaluation will be conducted in 2012.
2008	No change in status.
2009	No change in status.
2010	No change in status.
2011	No change in status. Massport provided updated data for the MassDEP website.
2012	Response Action Outcome submitted to MassDEP on December 27, 2012. No further MCP response action is required.
2. Former Robie Park (3-10027) - CLOSED 09/21/2016	
2005	A Phase I was completed in 2005 with a RAO retraction. The RAO had been completed by the former property owner.
2006	No change in status for 2006.
2007	No change in status for 2007.
2008	A Phase II Scope of Work was prepared on May 9, 2008. A RAM Plan was submitted to MassDEP on September 16, 2008.
2009	A Phase V Remedy Operation Status Plan was submitted on March 31, 2010.
2010	Two Remedy Operation Status Reports were submitted on September 29, 2010 and March 28, 2011. The next status report was scheduled for September 30, 2011.
2011	Phase IV Project Status Reports 2 and 3 were submitted in March and September 2011, respectively.
2012	Phase V Status Reports 4 and 5 were submitted in March and September 2012, respectively.
2013	Phase V Status Reports 6 and 7 were submitted in March and September 2013, respectively.
2014	Phase V Status Reports 8 and 9 were submitted in March and September 2014, respectively.
2015	Phase V Reports 10 and 11 were submitted in March and September 2015, respectively.
2016	A Permanent Solution Statement was submitted in 2016.
3. Former Robie Property (3-23493) - CLOSED 01/04/2010	
2005	A Phase I was completed in 2005.
2006	No change in status for 2006.
2007	No change in status for 2007.
2008	A Phase II was submitted to MassDEP on October 21, 2008.
2009	An Activity and Use Limitation (AUL) was recorded with the Suffolk County Registry of Deeds for the site on December 16, 2009.

Table J-18 Massport Contingency Plan (MCP) Closed Sites at Logan Airport (Continued)

Location (RTN) and MassDEP Reporting Status	Action/Status
3. Former Robie Property (3-23493) - CLOSED 01/04/2010 (Continued)	
2010	A Class A-3 RAO was submitted on January 4, 2010, corresponding with the recording of an AUL. On May 21, 2010, a RAM Plan for the Economy Parking Structure was submitted. The first RAM Status Report was submitted on September 21, 2010. An AUL Amendment was recorded on December 9, 2010.
2011	A RAM Completion Statement was submitted on March 15, 2011. Regulatory closure has been achieved. No further response actions are required.
4. Tomahawk Drive (3-27068) - CLOSED 08/20/2008	
2007	Release notification form submitted in August 2007.
2008	A Class B-1 RAO was submitted to MassDEP on January 9, 2009. No further response actions were required.
2009	No further response actions were required.
2011	No further response actions required.
5. Southwest Service Area Overflow Lot/Tomahawk Drive (3-28792) – CLOSED 10/18/2018	
2009	Release notification form was submitted to MassDEP/BWSC on October 8, 2009.
2010	A Class B-1 RAO was submitted to MassDEP on October 18, 2010. No further response actions required.
2011	No further response actions required.
6. Taxiway D (3-29716) – CLOSED 12/21/2011	
2010	Release notification form was submitted on December 22, 2010.
2011	A Class A-1 RAO was submitted on December 23, 2011. No further response actions required.
7. West Outfall Release (3-29792) – CLOSED 02/07/2012	
2011	Release notification form was submitted on April 8, 2011. Two IRA Status Reports were submitted to MassDEP on June 9 and December 5, 2011. A RAO was submitted on February 13, 2012. No further response actions required.
8. Hertz Parking Lot Site (3-30260) – CLOSED 09/05/2012	
2011	Release notification form was submitted on August 29, 2011. A RAM Plan was submitted to MassDEP on September 1, 2011.
2012	A Class A-2 RAO was submitted on September 10, 2012. No Further response actions required.
9. Former Butler Aviation Hangar (3-30654) – CLOSED 11/12/2014	
2012	Verbal notification of a release was provided to MassDEP on February 14, 2012, when Rental Car Center construction encountered an unidentified underground storage, and a Release Notification Form was submitted on April 23, 2012. An IRA Plan was submitted May 21, 2012 and IRA Status Reports were submitted on June 18 and December 26, 2012.
2013	Phase I Report and Tier Classification submitted February 21, 2013 and IRA Completion Report submitted on July 11, 2013.
2014	A Permanent Solution Statement was submitted in October 2014. No further response actions required.
10. Southwest Service Area/Porter Street @ Harborside Drive (3-32022) – CLOSED 11/20/2017	
2014	MassDEP notified of 72-hour Reportable Condition on March 10, 2014
2015	Phase I Report and Tier Classification submitted March 9, 2015.
2016	Permanent Solution Statement scheduled to be submitted in 2017
2017	A Permanent Solution Statement and AUL were submitted November 2017.
11. Former Hangar Building 16 (3-32351) – CLOSED 01/21/2016	
2014	Release Notification Form Submitted August 4, 2014.
2015	A RAM Plan was submitted on January 29, 2015; a Phase I Report and Tier Classification were submitted on August 3, 2015; a RAM Completion Report was submitted November 16, 2015; and a Permanent Solution Statement was submitted on January 21, 2016. No further response actions are required.

Source: Massport

Notes: RTN = Release Tracking Number. This list includes Massport MCP sites only. Additional sites are the responsibility of Logan Airport tenants. Refer to Figure 8-2 in Chapter 8, *Environmental Compliance and Management/Water Quality,* for location of active MCP sites.

AUL Activity and Use Limitation
FDS Fuel Distribution System
IRA Immediate Response Action
MCP Massachusetts Contingency Plan
Phase I Initial Site Investigation
Phase II Comprehensive Site Assessment
Phase III Identification, Evaluation, and Selection of Comprehensive Remedial Actions
Phase IV Implementation of Selected Remediation Action
Phase V Operation, Maintenance and/or Monitoring
RAM Release Abatement Measure
RAO Response Action Outcome

FIGURE J-1 **Massachusetts Contingency Plan Sites (Closed)**

2017 Environmental Status and Planning Report

1. North Outfall (3-4837)
2. Former Robie Park (3-10027)
3. Former Robie Property (3-23493)
4. Tomahawk Drive (3-27068)
5. Southwest Service Area Overflow Lot/ Tomahawk Drive (3-28792)
6. Taxiway D (3-29716)
7. West Outfall Release (3-29792)
8. Hertz Parking Lot Site (3-30260)
9. Former Butler Aviation Hangar (3-30654)
10. Southwest Service Area/Porter Street @ Harborside Drive (3-32022)
11. Former Hangar Building 16 (3-32351)

0 450 900 1800 Feet

This Page Intentionally Left Blank.

Sustainable Massport

A NEWSLETTER PUBLISHED QUARTERLY FOR MASSPORT AND ITS TENANTS I VOL 43, ISSUE 1, May 2017

Upcoming Events

Monday, May 15, 2017
Tuesday, May 16, 2017
Logan Facilities EMS Recertification Audit

Friday, May 19, 2017
Bike to Work Day

Thursday, June 1, 2017
Start of Hurricane Season

Monday, June 5, 2017
World Environment Day

Thursday, June 8, 2017
World Oceans Day

Wednesday, June 14, 2017
Flag Day

Food Waste Collection at the LOC

Food Waste Container

The Logan Office Center expanded its food waste collection program in March to encompass the entire building after a successful pilot program. In addition to collection in the Café, each department's kitchen has a food waste collection bin. Food waste is collected by Massport's waste hauler and taken to a farm in Saugus where it is converted to compost.

Currently the Logan Office Center has a 50% recycling rate. With successful implementation of food waste collection and improved recycling, the Logan Office Center will strive for a recycling rate of 60% by the end of 2017. If your organization is interested in collecting food waste, please contact Jacob at JGlickel@massport.com.

What goes in a food waste bin:

- Coffee pods and tea bags,
- Flowers and plant clippings
- Apple cores and banana peels
- Vegetables
- Meats and cheeses
- Bread and pizza

Compliance Corner - Emergency Engines

Increasingly as facilities are being built or upgraded, diesel fired emergency generators or fire pumps are installed. Many Massport tenants currently operate one or more emergency engines at their facility but are not familiar the recordkeeping or reporting requirements. Beginning in 2006, all stationary emergency engines greater than 37 kW engine output (49 HP) are regulated by MassDEP. Emergency engines require notification to MassDEP within 60 days of first operation, documentation to prove that they meet current emission restrictions and ongoing recordkeeping to ensure that use is limited to 300 hrs per year.

Additional requirements include minimum exhaust stack height and keeping of records documenting that proper ongoing maintenance has been performed and only the proper grade of diesel fuel is used. Emergency engines must also be located in an area that will not impact building air intakes or cause poor air quality in the surrounding area.

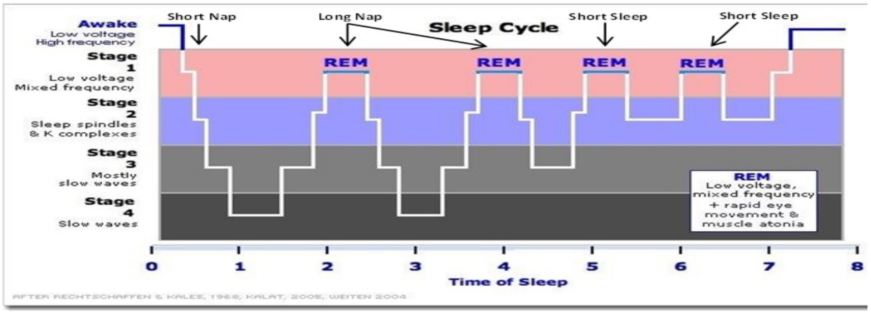
More information can be found on the MassDEP website at:

http://www.mass.gov/eea/agencies/massdep/air/approvals/stationary-engines-and-turbines.html

If you have any questions or concerns about hazardous waste compliance, contact the Massport Environmental Management.


Emergency Diesel Generator at Building 15, Logan Airport

Managing Fatigue in the Workplace



Caption goes here.

Getting plenty of sleep is a very important part of your personal safety. How did you sleep last night? Did you get enough sleep? How do you know? It is very important to be aware of yourself. Most people need 7-8 hours of sleep each 24-hour day. Sleep loss built up slowly over several nights can be as harmful as sleep loss in one night. Both produce a decline in performance such as slower reaction times, failure to respond to changes, the inability to concentrate, and make reasonable judgments.

Testing of fatigued persons against persons with blood alcohol levels concluded that 17 hours awake is equivalent to a blood alcohol content of 0.05. Twenty-one hours awake is equivalent to a blood alcohol content of 0.08 and 24-25 hours awake is equivalent to a blood alcohol content of 0.10.

EFFECTS OF FATIGUE:

- Higher likelihood of a musculoskeletal pain and other injuries.
- Higher risk of vehicular accidents.
- Lower morale and decreased motivation and productivity.

TIPS FOR REDUCING FATIGUE:

- Muscular Activity - Stand up or take a walk on a break to improve alertness.
- Environmental Light - Take a break in an area with bright lights (outdoor or indoor).
- Temperature – Cool, dry air, especially on your face can help keep you alert
- Sound – Irregular or variable sounds, such as radios, conversation or horns can stimulate alertness. Talk to a co-worker for a few minutes to stimulate your mind.
- Aroma – Studies have actually found that the smell of peppermint makes people more alert.
- Food/Snacks – Snack on pretzels, fruit or vegetables which have complex carbohydrates. Avoid candy and other sugary food. Avoid large meals before bedtime which can make it difficult to fall asleep.
- Sleep - Develop a schedule for sleep and stick to it. The average person does best with 7.5-8 hours of sleep or 4-5 REM cycles. Keep the room dark with no distractions.
- Avoid – Before going to sleep avoid caffeine and nicotine which can make it harder to fall sleep and alcohol which may help you fall asleep, but reduces to quality and amount of REM sleep.
- Phones/Tablets/TV – Set phone/tablet display to night setting. The blue light from phones and TVs can stimulate the brain and keep you awake.
- Recovering – Two full sleep cycles should reset your system and reduce fatigue.
- Exercise - Regular exercise will reduce the amount of time it takes you to fall asleep.

Getting plenty of sleep is a very important part of your personal safety.

**Naps are best if they are very short (15-20 minutes) or very long (about 90 minutes). Naps between 20 and 90 minutes allow your body to fall into a deep sleep, but do not let you finish the sleep cycle, leaving you feeling groggy and disoriented when you awake.*

New Climate Mitigation and Resiliency Manager

Please welcome Peter DeBruin to Massport as the new Climate Mitigation & Resiliency Manager. Peter is part of Capital Programs & Environmental Affairs, reporting to Brenda Enos. His work focuses on ensuring that Massport's infrastructure and assets are protected from severe weather such as stormwater flooding and sea level rise, while reducing environmental impact from operations and enhancing performance. Peter will collaborate with teams across Massport to achieve the mission of reducing environmental risk and impact, and further advancing the positive environmental results that can be achieved through a focus on buildings and operations. Upcoming efforts for Peter include coordinating the testing of the deployment of flood barriers to protect critical assets, ensuring that Massport-wide flood operations plans are fully operational, and working with Capital Planning project managers to incorporate guidelines into the planning of projects. He was previously the Global Program Manager for State Street Corporation's Office of Environmental Sustainability, and prior to that worked at Fidelity Investments and Xerox Corporation. He has a bachelor's degree from the University of Maine at Orono, and a Masters in Business Administration from Michigan State University.

Peter will collaborate with teams across Massport

MASSPORT CONTACTS

Safety	Environmental Compliance	Sustainability	Recycling
Brian Dinneen I 617.568.7427	Ian Campbell I 617.568.3508	Jacob Glickel I 617.568.3558	Jacob Glickel I 617.568.3558
bdinneen@massport.com	icampbell@masspot.com	jglickel@massport.com	jglickel@massport.com

Sustainable Massport

A NEWSLETTER PUBLISHED QUARTERLY FOR MASSPORT AND ITS TENANTS I VOL 43, ISSUE 2, SEPTEMBER 2017

Upcoming Events

September
National Preparedness Month
www.ready.gov/september

Wednesday, September 20, 2017
Logan Safety Fair

October
Energy Awareness Month
www.masssave.com

Wednesday, November 15, 2017
America Recycles Day

Terminal E Project gets Green Recognition

Terminal E

The recently completed John A. Volpe Terminal E New Large Aircraft Wing has received LEED (Leadership in Energy and Environmental Design) Gold certification for Commercial Interiors from the US Green Building Council.

This project provides expanded hold room space for 3 international gates that can accommodate large aircraft such as the A380 double-decker planes. Massport is an environmental leader through the incorporation of sustainability standards within our projects and has set ambitious goals to obtain LEED certification for all of our major building projects.

The 31,465 square feet of Terminal E Departures Level 3 of the New Large Aircraft Wing was certified under the Commercial Interior rating system in August 2017. Some sustainable project highlights include:

- Reduced water efficiency by 38% using low flow water fixtures and water closets
- Lighting power reduced by 43% and HVAC energy use reduced by 19% below code
- 83% of construction waste, about 862 tons, was diverted from landfills and incineration facilities
- The open space and windows in the concourse provides over 90 degree views of the outside achieving an exemplary performance credit
- 95% of wood used was certified in accordance with the Forest Stewardship Council which encourages environmentally responsible forest management.

Universal Waste — Light Bulbs — Compliance Reminder

Massachusetts has bans on the disposal of certain hazardous and recyclable items. Included in this list are mercury and mercury-containing products and those containing polychlorinated byphenyls (or PCBs). These products must be separated from trash, contained during transport and storage, and disposed of properly. Many pieces of equipment that you encounter on a daily basis contain mercury, such as fluorescent light bulbs and thermostats, and PCBs can be found in lighting ballasts. During normal use of these items, small amounts of mercury and PCBs contained within pose no harm to you or the public. However, when mishandled or improperly disposed, the chemicals can be released into the environment.

The following steps should be followed to properly handle, store and dispose of those items containing mercury or PCBs:

1. PLACE items in a container, such as a plastic bin or cardboard box.

   a. Reinserting in the original box (for instance, in the case of spent fluorescent bulbs) is acceptable.

   b. Broken bulbs must be stored in a sealed container (such as a 5 gallon bucket with a lid) marked as "Hazardous Waste", since the mercury has now been released from its original manufacturer's sealed condition.

2. LABEL the container as to its contents and date collection begins.
3. STORE the container within the Universal Waste Storage Area.

In case of breakage, a spill cleanup kit should be readily available.

Reclaimed debris from breakage or spills should be placed in a sealed container.

Each terminal has a single designated storage are for "Universal Waste". All mercury containing items will be consolidated in these areas at the end of each work shift and retrieved by a reclamation contractor on a quarterly basis.

Together, we can effectively manage our mercury containing refuse, protect our working environment, and ensure a clean sustainable environment for future generations.

What is the 20-20-20 Safety Initiative?

Workplace hazards and environmental risks can exist all around you and conditions are constantly changing. Each employee needs to have a situational awareness of the dangers associated with their own work as well as work being performed around them by others. Here is a simple act you can do to help; **20**-**20**-**20**:

Take **20** seconds, every **20** minutes and look **20** feet around you for safety. Look up, down and in every direction around you. Correct safety and environmental issues if possible. If you can't correct the issue, report issues to your Supervisor or Company Safety Officer. Some items you can look for include:

- Where are my exit routes?
- Are aisles around me clear and are floors in good shape?
- Are ceilings and signs secured?
- Is there enough light for my work?
- Are my walking surfaces slippery?
- Are ladders being used properly?
- Do I see unlabeled chemicals?
- Are flammables stored properly?
- Do I see guards on equipment missing or damaged?
- Am I working under any hazards?
- Am I wearing my PPE? What about the people around me?
- Are traffic control devices effective for road work?
- Are electric cords safe?
- Is fall protection being used when required?

Each employee needs to have a situational awareness of the dangers associated with their own work as well as work being performed around them by others. Here is a simple act you can do to help; 20-20-20:

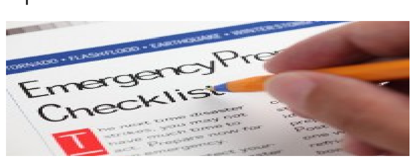
This safety mindset will help you to be aware of your surroundings. It is a proactive and preventative action that will help you own the area around you for your safety and the safety of everyone. If you need any assistance with implementing **20**-**20**-**20** or you would like to share a **20**-**20**-**20** success story, please reach out to a member of the Massport Safety Unit.

September – National Preparedness Month

September is National Preparedness Month, and with a busy hurricane season, it is important to plan ahead and prepare for emergencies before they happen. There are a number of resources including the National Hurricane Center website at http://www.nhc.noaa.gov/prepare/ready.php and Massachusetts Emergency Management Agency www.mass.gov/mema/hurricanes.

These sites include information about how to sign up for alerts and notifications, what evacuation zone you may live in, how to prepare a family emergency plan, and what to include in an emergency kit. Hurricanes have the power to cause widespread devastation and can affect both coastal and inland areas.

Although the Atlantic hurricane season is officially June 1 through November 30, the most active time for these storms in Massachusetts is late August through September.




bostonlogan massport
LOGAN SAFETY FAIR
EXHIBITORS • BBQ • PRIZES
SEPTEMBER 20th
10:30AM - 2:00PM
JETBLUE HANGAR
(Directly across from the North Gate.
Accessible from airside and landside.)
Questions: Contact Debra Guerette at 617 561 1922 or
e mail at DGuerette@massport.com
THINK
SAFETY

Sustainable Massport

A NEWSLETTER PUBLISHED QUARTERLY FOR MASSPORT AND ITS TENANTS I VOL 43, ISSUE 4, DECEMBER 2017

Upcoming Events

January, 2018
2018 Sustainability Calendar

January 23, 2018
Construction Safety Partnership Mtg

January 26, 2018
Health and Wellness Fair

April 22, 2018
Earth Day

2018 Massport Calendar

The 2018 Sustainable Massport Calendar is now available for all Massport employees and tenants. The 2018 calendar showcases sustainability efforts across all Massport facilities, including: Hanscom Field, Worcester Regional Airport, Parks, Real Estate Holdings, and the Port of Boston. The annual Sustainable Massport Calendar is part of the engagement strategies laid out in the Logan Airport Sustainable Management Plan (SMP), published in 2015.

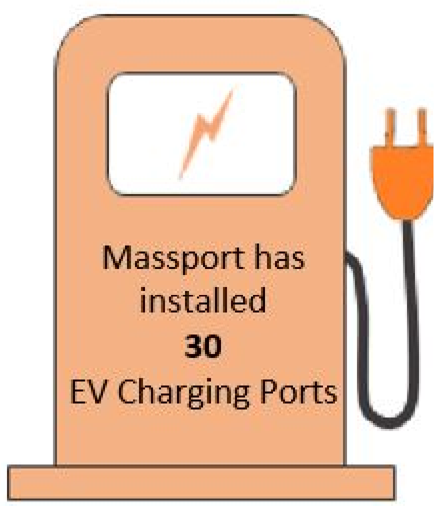
The Logan SMP serves as a roadmap to advance Massport's leadership and commitment to sustainability, by prioritizing and implementing initiatives that emphasize economic viability, operational efficiency, natural resource conservation, and social responsibility. The Sustainable Massport Calendar is one tool to share Massport's sustainability successes, and raise awareness about the organization's commitment to sustainability. Each month within the calendar will highlight a different sustainability- related topic,associated activities which Massport has undertaken and its progress, as well as ideas of programs and actions which individuals can participate in to improve personal sustainability at work and home.

If you like to receive a 2018 Calendar or would like additional copies to distribute, please contact Jacob Glickel at jglickel@massport.com

Fish Pier & Black Falcon Terminal Achieve Environmental Certification

The Fish Pier and Black Falcon Terminal have joined the Conley Terminal in achieving the globally recognized environmental risk and performance management standard ISO 14001. The certification at the two additional locations was achieved based on the identification of significant environmental impacts, and then setting objectives and measurable targets to manage those impacts. Through a series of preparatory compliance reviews and audits that engaged stakeholders throughout Marine Operations, the Fish Pier and Black Falcon Terminal then passed a final audit in mid-December, and became certified shortly after the audit.

Little known fact:



Recycling Corner

Contamination happens when incorrect items are placed into single-stream recycling bins. Contaminated recycling jeopardizes the success of the whole program since it can cause the entire load to be redirected to landfill—even if there are recyclable items mixed in there! Please help us recycle responsibly. Common contaminants that **CANNOT** be recycled include:

- **Black or colored bags**
- **Latex gloves**
- **Food waste**
- **Styrofoam**
- **Plastic Shrink-wrap**
- **Paper towels/Napkins**
- **Fabric (E.g., blankets, pillows, clothing)**

Compliance Corner - Annual Tier 2 Reporting

Many Massport tenants are required to submit annual reports to satisfy the Emergency Preparedness and Community Right to know Act (EPCRA). For 2017 there are changes in the way that chemicals are reported. For facilities reporting hazardous chemicals under sections 311 and 312 of EPCRA, Chemical reporting must be done using the OSHA Globally Harmonized Standard (GHS) beginning in 2017. Submissions must utilize GHS compliant Safety Data Sheets or a chemical list utilizing the revised OSHA HAZCOM hazard categories. For chemical mixtures, facility owners may need to develop their own SDS for each mixture. Don't wait until the deadline to find out what the changes mean to you.

Chemicals store above Tier 2 thresholds must be report annually by March 1st to the Local Emergency Planning Committee (LEPC) or regional Emergency Planning Committee (REPC) AND to the local fire department.

More information on Massachusetts Tier 2 reporting requirements can be found at:

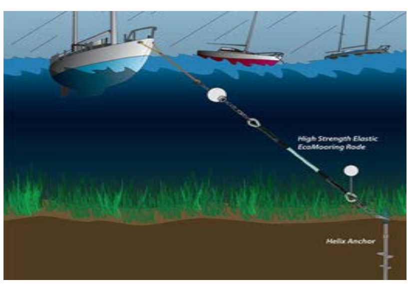
http://www.mass.gov/eopss/agencies/mema/resources/serc/

And at the EPA website:

https://www.epa.gov/epcra/tier-ii-forms-and-instructions

If you have any questions or concerns about hazardous waste compliance, contact the Massport Environmental Department.

Massport's Environmental Mitigation for Logan's Runway Safety Area Improvement Project is Flourishing!



Conservation mooring schematic

In 2014, Massport began its Conservation Mooring Program in five separate harbors as an alternative mitigation strategy for the loss of an eelgrass meadow when the critically important Logan Runway Safety Area was constructed for Runways 33L. Over the past three years, Massport, with field support from Massachusetts Division of Marine Fisheries, has been annually assessing the environmental recovery of eelgrass in scars formed from convention boat moorings. By funding the replacement of 218 conventional moorings (typically block and chain) with conservation moorings, the footprint on the harbor bottom is essentially eliminated. In addition, the neutrally buoyant mooring rode eliminates bottom drag which can damage eelgrass. Over the past three years, signs of eelgrass recovery have been observed and this year, the harbor-wide scar area has measurably declined in each harbor. An additional benefit includes a reduction in localized turbidity which makes for an improved habitat for shellfish and fish.

Eelgrass filling in the mooring scar at Gloucester helix anchor DC-13-19. Division of Marine Fisheries scientist assessing eelgrass growth.

Eelgrass growing up to the West Falmouth Harbor #156 helix anchor

Safe Winter Driving - The Three P's of Safe Winter Driving:

PREPARE for the trip;
PROTECT yourself; and
PREVENT crashes on the road

PREPARE

- Check tire tread, headlights, brake lights, windshield wipers and windshield washer fluid prior to driving.
- Completely clear snow and ice off your car – including windows, mirrors, lights, reflectors, hood, roof and trunk.
- Have a snow brush and ice scraper in the vehicle.

PROTECT YOURSELF

- Always use your seat belt while driving or when you are a passenger in a moving vehicle.
- Watch for ice when stepping in and out of the vehicle. Most falls happen when getting in and out of vehicles during the winter months. Use three three points of contact while getting in and out and use caution.
- Always wear high visibility clothing when working around vehicles at roadways, garages, container yards and ramp areas.
- Make sure your exhaust pipe is clear of snow. There is danger of carbon monoxide poisoning if snow blocks the pipe while idling. Remember- do not idle more than 5 minutes per MassDEP regulation.

PREVENT CRASHES

- Stopping distances are longer on snow and ice. Slow down and increase distances between cars.
- Keep your eyes open for pedestrians walking in the road. Visibility can be low during snow storms. Ensure you use caution around terminal and ramp areas or near the road.
- Drive with your headlights on, and be sure to keep them clean to improve visibility.
- Use caution when snow banks limit your view of oncoming traffic.
- Be cautious on bridges and overpasses as they are commonly the first areas to become icy.
- Remember that speed limits are meant for dry roads, not roads covered in snow and ice. You should reduce your speed and increase your following distance as road conditions and visibility worsen.

Recycling Christmas Trees

Don't throw your real Christmas tree in the trash after the holidays. Real trees are biodegradable, which means they can be easily reused or recycled. Consider giving your tree a second life as compost, mulch, or chips to be used later in a garden or landscape project. Other options include: reusing your tree for bird feeders, or for a soil erosion barrier. The Massachusetts Christmas Tree Association provides a link to locations of Christmas Tree Recycling Centers in Massachusetts

Visit http://www.christmas-trees.org to get recycling center locations for Christmas trees as well and other materials.

Real Christmas Trees can be easily reused or recycled.

Remember to also recycle Christmas wrapping paper and boxes. Bows and ribbons cannot be recycled, so instead should be reused and ultimately put in the trash.

Holiday Safety Tips

Winter Holidays are often a time for fun and festivity. Too often, they also mean accidents and injury. Tens of Thousands of people are injured over the Holiday Season. Accidents range from fires to fall hanging decoration. Please remember *The 12 Days of Safety* that is published by the National Safety Council. Enjoy the Season!

February is sustainable transportation month as part of Sustainable Massport. Massport is dedicated to providing Massport staff multiple ways to get to work without having to drive their own vehicle. Every car that isn't coming to Logan or other Massport facilities, reduces stress on existing roadways and reduces greenhouse gas emissions.

How to Put the Brakes on Driving Alone to Work

Transit and Vanpool Discounts

- All full, part-time, and job share employees are eligible for 50% reduction off the cost of their public transportation commuting costs, up to $100 per month.
- Employees can take advantage of this program either through reimbursement or on a pretax basis from your paycheck.
- Eligible mass transportation options include MBTA transit, Logan Express buses, Inner Harbor Ferry, Commuter Boat, vanpool and privately operated scheduled buses. For more information, please contact Emily Navarro at x3937, except regarding Vanpools. Matt Carrai of Rideshare by Enterprise can be contacted at Matthew.d.carrai@ehi.com or 508-259-8959 for information on establishing a vanpool.

Massport Shuttles

- Shuttles circulate the airport, making it easy to connect to the Blue Line (Airport Station), the Silver Line, Logan Express, privately operated scheduled buses, and water transportation
- Shuttles run during the work week between the LOC, Terminal C and the Blue Line every 15 minutes from 7:30 - 9:30 AM and 2:00 - 6:00 PM.

Logan Express

- Employee discounts on fares and parking are available at all Logan Express locations, including Framingham, Braintree, Woburn, and Peabody. Discounts are also available on the Back Bay Logan Express.
- For tickets, please contact Emily Navarro at x3937.

Water transportation

- Massport employees can ride the water taxi free of charge Monday – Friday from 7:15 – 9:15 AM and 3:30 – 5:30 PM with a Massport badge all-year round.
- Pre-paid vouchers are also available for work-related travel during other hours. For more information, contact Jamila Richardson at x1756.
- Valid for transportation between the following docks: Logan, Long Wharf, Central Wharf, Rowes Wharf, Moakley Court House, and World Trade Center.

Biking or Walking

- Massport offers bike racks around Logan airport and at other facilities for convenient bike parking.
- Shower facilities are available at the LOC (for badged employees) and may be available at other facilities (check with your supervisor for access and availability).

The Recycling Corner

Test Your Recycling Knowledge! Take our short quiz and find out if you are an expert on the dos and don'ts of recycling at Massport. All of your responses will be anonymous.

TAKE THE QUIZ

Massport's Sustainability Mission:

"Massport will maintain its role as an innovative industry leader through continuous improvement in operational efficiency, facility design and construction, and environmental stewardship while engaging passengers, employees, and the community in a sustainable manner."

Massport's Sustainability Mission
Massport will maintain its role as an innovative industry leader through continuous improvement in operational efficiency, facility design and construction, and environmental stewardship while engaging passengers, employees, and the community in a sustainable manner.

SUSTAINABLE MASSPORT MONTHLY NEWSLETTER

March 2018: Water Resources and Conservation

March is Water Resources and Conservation month as part of *Sustainable Massport*! Massport has taken significant steps to track and reduce water at our facilities. At Hanscom Field, a tenant project by Boston MedFlight built a new hangar reusing on-site groundwater to minimize dust created during construction.

Water Reuse Project at Hanscom Field

Conserve Water at Home
There are easy steps you can do at home to reduce your own water use.

- Turn off the tap while brushing your teeth or shaving: save 4-10 gallons a day.
- Never use your toilet as a wastebasket: save 1.5-4 gallons per flush.
- Don't take marathon showers: five minutes will get you clean. Save 3-7 gallons per shower.
- Close your tub drain before turning on the water: save 3 gallons or more.
- Fill your bathtub only halfway: save 5 gallons or more. You will save hot water costs, too.
- Faucets typically use 2 to 5 gallons per minute. Installing a low-flow faucet aerator can reduce the flow by as much as 25% or up to a gallon and a half per minute.

The Massachusetts Water Resource Authority (MWRA) provides information about water conservation at www.MWRA.com, and will also provide a water saving kit if you live in a MWRA customer community.

In 1986, MWRA customers used a total of 330 million gallons of water per day. Thanks to daily water conservation efforts, demand has been reduced to 195 million gallons per day in 2017. Saving water keeps supplies level and has helped the region control water, sewer and energy costs.

THE RECYCLING CORNER | COMMON CONTAMINANT » FOOD WASTE

Please do not put food waste into Massport's single-stream recycling bins.

Empty and rinse food containers before recycling.

Massport's Sustainability Mission
Massport will maintain its role as an innovative industry leader through continuous improvement in operational efficiency, facility design and construction, and environmental stewardship while engaging passengers, employees, and the community in a sustainable manner.

SUSTAINABLE MASSPORT MONTHLY NEWSLETTER

April 2018: Health and Wellness

April is Health and Wellness month as part of *Sustainable Massport*! In its commitment to enhancing the health and well-being of its employees, Massport is currently offering the following programs:

Employee Health and Wellness

- **HR Open House** will be held on Wednesday, April 11 from 11-2 @ LOC. Open Enrollment will run April 4-May 2 with an effective date of July 1st.
- **Health & Wellness related classes** are available in April and throughout the year as a part of the Health & Wellness Incentive Program including:
  - April 4 - Post-Overdose Response
  - April 11 - Diabetes Awareness
  - April 24 – Work Addiction
- The Human Resources Department would like to remind employees about the partnership we have with Blue Cross Blue Shield of Massachusetts (BCBS) that brings **all** of our employees (including those who do not have health coverage through BCBS) a health & wellness online offering via BCBS's **wellness website** www.ahealthyme.com/login. If you need assistance with creating an account, please contact Tonya Walker at extension 7436.
  - *A few of the website highlights include:*
    - A health assessment that looks at eight different areas of your health and provides you with a personalized wellness score
    - Self-paced on-line workshops on a wide range of topics
    - Tools to help you stay on a healthy track, including nutrition and exercise logs, a recipe library, and a meal planner

Community Events

- **East Boston Little League Opening Day** will be held on April 28th at Massport's Festa Field.

THE RECYCLING CORNER

RECYCLE THIS, NOT THAT

A Case of Bottled Water in Plastic Wrap Packaging

massport Recycles

RECYCLE

Plastic Bottles
(no liquids)

Cardboard
(clean, flattened)

Questions? Contact Lauren Laskey
(LLaskey@massport.com, 617-568-3542)

TRASH

Plastic Wrap Packaging

The stretchy plastic wrap packaging that surrounds the outside of a multi-pack of bottles CANNOT be placed into Massport's single-stream recycling containers.

Many stores offer special recycling programs for plastic wrap. Find store drop-off locations: http://www.how2recycle.info/sdo

Massport's Sustainability Mission
Massport will maintain its role as an innovative industry leader through continuous improvement in operational efficiency, facility design and construction, and environmental stewardship while engaging passengers, employees, and the community in a sustainable manner.

SUSTAINABLE MASSPORT MONTHLY NEWSLETTER

May 2018: Parks and Open Space

May is Parks and Open Space month, as part of Sustainable Massport. Massport owns and operates over 30 acres of parks that provide open space, playgrounds, and waterfront views to our neighbors. In addition, our parks also provide critical environmental benefits such as tree canopy and carbon absorption that protect human health and physical property.

Massport parks and open space have offer a great benefit to the community and employees including events and activities for the whole family.

East Boston Parks

- Take a lunch time walk to Piers Park, Navy Fuel Pier, Neptune Road Buffer, Maverick Mothers Pocket Park, and the East Boston Greenway
- The Sailing Center located at Piers Park had its opening day on April 28, and local residents enjoyed sailboat rides and learned about the summer programs at the center
- Starting in July, Zumix, a local non-profit, will be holding free concerts at Piers Park every Sunday at 6pm through the end of August
- The water fountain at Bremen Park will start on the first day of summer vacation for Boston public schools
- Bremen Park has a community gardens section where residents grow flowers, fruit and vegetables all summer long

Piers Park in Bloom

South Boston Parks

- Food trucks operate at South Boston Maritime Park five days a week, Monday – Friday. The trucks are stationed on Northern Avenue from 11:00AM-3:00PM. In addition to the trucks, corn hole boards and Adirondack chairs are in the park for all to enjoy.

Massport's Sustainability Mission
Massport will maintain its role as an innovative industry leader through continuous improvement in operational efficiency, facility design and construction, and environmental stewardship while engaging passengers, employees, and the community in a sustainable manner.

SUSTAINABLE MASSPORT MONTHLY NEWSLETTER

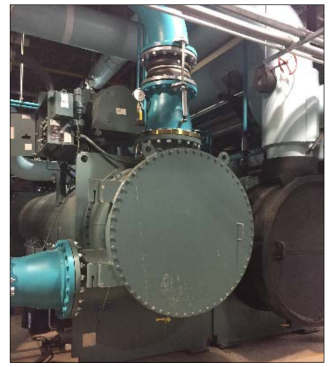
June 2018: Air Quality and Greenhouse Gas Reduction

June is Air Quality and Greenhouse Gas Reduction month, as part of Sustainable Massport. As Massport upgrades our buildings and operations, we are making great strides to invest in air quality and greenhouse gas reduction improvement technologies. These critical improvements will benefit neighboring communities and improve the efficiency of Massport operations.

Examples of air quality improvements and greenhouse gas reductions related projects at Massport include:

Boston Logan International Airport

- 2 new chillers at the Central Heating and Cooling Plant are 30% more efficient than their replacements
    - Last year, new cooling tower extensions were installed at the plant, increase cooling capacity by 15%
- As part of the relocation of the taxi lot to Harborside Drive, Massport is installing four fast charging electrical vehicle charging stations at the new taxi lot.
- 65 new dual charging stations for airline ground service equipment will be installed as part of the Terminal B Optimization project in early 2019.



New Chiller at Central Heating and Cooling Plant

Conley Terminal

- Five rubber tired gantry (RTG) cranes are being upgraded to tier four engines this summer. Air quality improvements from these upgrades will result in a 90% reduction in nitrous oxides and a 13% reduction in particulate matter.

RTG crane engine

massport Recycles

Questions?
Contact **Lauren Laskey**
LLaskey@massport.com
617-568-3542

Find out where you can recycle styrofoam:
www.foamfacts.com/recycling/

Massport's Sustainability Mission
Massport will maintain its role as an innovative industry leader through continuous improvement in operational efficiency, facility design and construction, and environmental stewardship while engaging passengers, employees, and the community in a sustainable manner.

SUSTAINABLE MASSPORT MONTHLY NEWSLETTER

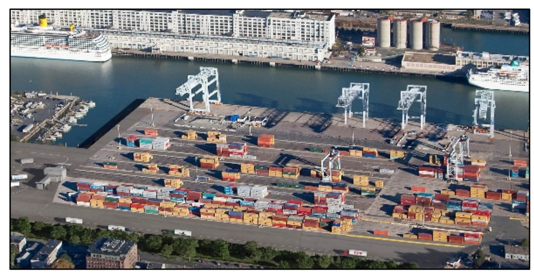
July 2018: Natural Resources

July is Natural Resources month, as part of *Sustainable Massport*. Massport's natural resources, including wetlands, creeks, woods, tidal salt marshes, and mud flats, provide habitat for a wide variety of plants and wildlife. Massport continuously seeks to protect our regions' natural resources while maintaining safe aircraft and vessel operations.

Snowy Owl Trap and Relocation

The Massport Wildlife Management Department partners with a certified airport wildlife biologist to assess and manage all wildlife at Logan Airport. Between November 2017 and July 2018, 94 snowy owls have been trapped and relocated from Logan's airfield through a cooperative relationship between Mass Audubon, the USDA-APHIS Wildlife Services, and Massport. Since the early 1990's, this partnership helped to protect snowy owls, improved our understanding of the species, and promoted aviation safety. Before releasing them back into the wild, researchers attach bands and transmitters to the owls. This allows researchers to learn more about their migratory and behavioral patterns, which had been relatively unknown due to their remote Artic habitat.

Berth 10 at Conley Terminal Soil Remediation



Berth 10 Rendering

The new Berth 10 project at Conley Terminal will restore a former oil terminal to active marine use by removing dilapidated pier structures and constructing a new modern facility. In addition to constructing a pile-supported concrete pier and installing new cranes, this project will remove oil-impacted soil and install a new bulkhead to contain any remaining contamination onsite and prevent oil from seeping into the harbor. Oil-impacted soils will be excavated from the shoreline and dredged from the harbor at Berth 10. In addition to constructing the steel bulkhead, the project will create an additional containment barrier behind the bulkhead using a soil stabilization method.

Massport's Sustainability Mission
Massport will maintain its role as an innovative industry leader through continuous improvement in operational efficiency, facility design and construction, and environmental stewardship while engaging passengers, employees, and the community in a sustainable manner.

SUSTAINABLE MASSPORT MONTHLY NEWSLETTER

August 2018: Climate Change Adaptation and Resiliency

August is Climate Change Adaptation and Resiliency month as part of *Sustainable Massport.* The Boston region is in the middle of Hurricane Season (June 1 – November 30) and Massport has been implementing various resilience measures to ensure that staff and facilities are protected from potential effects of severe weather. Examples of efforts include enhancing critical infrastructure through permanent and temporary flood-proofing as well as conducting exercises to increase operational preparedness for storms.

The March Nor'easter

In March 2018, a nor'easter heavily impacted the Boston region. In preparation, Massport deployed temporary flood barriers at Maritime properties. This was Massport's first 'real-life' emergency deployment of barriers. Barrier installations were successful and effectively protected assets from surrounding floodwaters.

High Water at the Fish Pier

Test Deployment of Temporary Flood Barriers

The team has been developing strategies to continuously improve the program and address issues encountered during the March nor'easter, such as communication and logistical challenges. Some resilience initiatives include:

- Conducting a test deployment of temporary flood barriers at the MPA Pumping Station (Electrical Telecom Building) at Logan Airport in June. Routine trainings help to increase efficiency and preparedness for deployments.
- Developing a *Massport Flood Resiliency Application* through internal collaboration to improve communication and logistics during deployments.
- Evaluating 'next level' priorities and opportunities for improving flood and disaster resiliency at vulnerable locations

Test Deployment at the Fish Pier

Be Prepared at Home

It is important to be prepared for storms at home too! The *Red Cross Flood and Hurricane Safety Checklists* provide resources and tips that can help to keep your family and home safe. Additional resources are available on the [Massport Resiliency Sharepoint Page].

Massport's Sustainability Mission
Massport will maintain its role as an innovative industry leader through continuous improvement in operational efficiency, facility design and construction, and environmental stewardship while engaging passengers, employees, and the community in a sustainable manner.

SUSTAINABLE MASSPORT MONTHLY NEWSLETTER

September 2018: Community Partnerships

September is Community Partnerships month as part of *Sustainable Massport*! The support and well-being of the broader community and its schools is an important component of Logan Airport's sustainability goals. Community investment enhances the communities' ability to prosper and invest in their own development. In recognition of all the valuable community work undertaken this summer by dedicated Massport staff, here are highlights of the programs and projects we support.

Massport Backpack Program
Each summer, Massport coordinates a backpack drive for homeless and in-need children between the ages of 4 and 17. This year, Massport sponsored children at the Crossroads Family Center in East Boston, the Joseph M. Tierney Learning Center in South Boston and Heading Home in Charlestown. In August, 65 children received backpacks filled with school supplies and a new outfit for their first day of school- our highest response yet by Massport employees! This program is invaluable in strengthening the children's self-esteem, encourages them to look forward to the new school year, and sends a strong message that others care about them and their education.

Massport Food Drive
Each fall, Massport coordinates a food drive to help those less fortunate. For the upcoming Thanksgiving season, Massport is assisting three organizations: The Crossroads Family Center, The Winthrop Food Pantry and The South Boston Community Health Center (SBCHC) Food Pantry. Collections will begin on Monday, October 8, 2018 and end on Friday, November 9, 2018. An announcement will be made in October with the full details of the Massport Food Drive.

"Love Your Block" Neighborhood Cleanup
Massport proudly supports the City of Boston's "Love Your Block" neighborhood cleanup initiative. Each spring, Massport employees volunteer time to help beautify our neighboring communities by cleaning streets, painting, planting and weeding.

Massport's Sustainability Mission
Massport will maintain its role as an innovative industry leader through continuous improvement in operational efficiency, facility design and construction, and environmental stewardship while engaging passengers, employees, and the community in a sustainable manner.

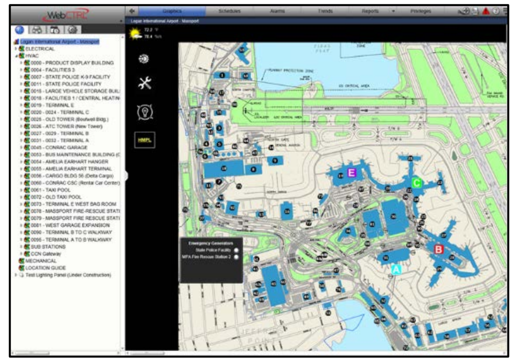
SUSTAINABLE MASSPORT MONTHLY NEWSLETTER

October 2018: Energy Efficiency

October is Energy Efficiency Month as part of *Sustainable Massport*! As Massport builds and upgrades facilities to keep up with passenger growth, we continue to invest in sustainable and energy reduction systems.

Master Building Control

Massport is expanding the ability to monitor and control all Logan Airport building operations remotely through a Master Building Control System (MBCS). This ensures peak operational performance of all HVAC and lighting systems, while expanding the opportunity to reduce energy consumption. Massport is converting and integrating our older building control systems onto the MBCS and new building systems are installed on the MBCS. As the MBCS encompasses more operations, staff are being trained to monitor the system remotely to more easily ensure peak performance for lighting and HVAC systems. The MBCS will also provide the opportunity for Massport to retro-commission the HVAC and lighting systems to reduce energy use.



Online Portal for Master Building Control System

Lighting Retrofits

- Conley Container Terminal recently retrofitted their high mast yard lighting with LEDs, cutting their energy use by half and resulting in over 175,000 kWh of energy savings.
- Since 2016, Massport has retrofitted over 6,200 lighting fixtures with energy efficient LEDs at Boston Logan Airport. The retrofits included lighting in the terminals, parking garages, streetlights, and airport facilities as part of a program designed to reduce energy use and improve lighting performance. The result is annual savings of 2,600 MWh of annual savings and a reduction of 890 metric tons of greenhouse gas (GHG) emissions!

Retrofitting streetlights with LEDs

THE RECYCLING CORNER

THANK YOU FOR RECYCLING THESE ITEMS

Scan the QR Code to learn more about the new statewide list of recyclable & non-recyclable items!

Metal

Food and Beverage Cans
empty and rinse

Plastic

Bottles, Jars, Jugs and Tubs
empty and replace cap

Glass

Bottles and Jars
empty and rinse

Paper & Cardboard

Mixed Paper, Newspaper, Magazines, Boxes
empty and flatten

Questions? Contact **Lauren Laskey** (LLaskey@massport.com; 617-568-3542)

massport Recycles

Massport's Sustainability Mission
Massport will maintain its role as an innovative industry leader through continuous improvement in operational efficiency, facility design and construction, and environmental stewardship while engaging passengers, employees, and the community in a sustainable manner.

SUSTAINABLE MASSPORT MONTHLY NEWSLETTER
November 2018: Waste Management and Recycling

November is Waste Management and Recycling Month as part of *Sustainable Massport*! Massport has been developing solutions to encourage waste reduction, reduce the level of contamination in the recycling stream, and increase the amount of materials properly recycled, despite industry-wide challenges.

Logan Airport Waste Assessment

Massport is conducting a comprehensive waste assessment of Logan Airport to augment our understanding of the waste streams, identify challenges, and develop recommendations for improving the waste management and recycling program. A robust plan is being developed, which will identify multi-pronged strategies to successfully implement recommended initiatives and promote continuous improvement of the waste management and diversion system.

Team conducts waste audit

Prevent Contamination and Recycle Right

Contamination occurs when improper items are placed into recycling containers. A small amount of contamination can cause all of the materials within a container to be diverted as trash to landfills--- even if there are 'good' recyclable items mixed in there! Therefore, it is important to learn what you can and cannot put into single-stream recycling.
If you are unsure if an item is recyclable, please throw it in the trash.

Please DO place these items in your blue bins!

Please do NOT place these common contaminants in your blue bins!

FOOD / LIQUID

PLASTIC BAGS

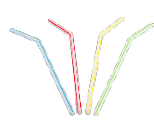
PLASTIC WRAP/FILM

FOOD/CANDY WRAPPERS

STYROFOAM

PAPER CUPS

STRAWS



PLASTIC UTENSILS

Questions? Contact Lauren Laskey (llaskey@massport.com; 617-568-3542)

Massport's Sustainability Mission
Massport will maintain its role as an innovative industry leader through continuous improvement in operational efficiency, facility design and construction, and environmental stewardship while engaging passengers, employees, and the community in a sustainable manner.

SUSTAINABLE MASSPORT MONTHLY NEWSLETTER
December 2018: Sustainable Tenants

December is Tenant Month as part of *Sustainable Massport*! Massport is proud to support our tenants' sustainable business initiatives. Examples of sustainable tenants at Logan Airport include but are not limited to: Legal Sea Foods and the Hilton Hotel.

Legal Sea Foods

To help protect the environment, Legal Sea Foods has adopted a variety of sustainable practices at Logan Airport. In May 2018, Legal Sea Foods eliminated the use of Styrofoam boxes for seafood deliveries to their six restaurants at the Airport. This initiative has significant environmental benefits by preventing roughly 20,000 non-recyclable Styrofoam boxes from entering landfill each year. In addition, their new cardboard box delivery method will contribute to improving the recycling rate at the Airport. In an effort to reduce the use of single-use plastics, the restaurants began offering paper, compostable straws in July 2018.

Hilton Hotel

The Hilton Hotel at Logan Airport has implemented a variety of sustainability initiatives to reduce environmental impacts. In March 2018, the hotel initiated a large-scale composting program for food waste collected in kitchens. Within the first six months, the program helped to divert more than 95,000 lbs. of organic materials from landfill. This equals 47.5 tons or almost 10 elephants! Compost created through this program is used to enrich soil and grow fresh vegetable gardens at roughly 50 schools and colleges in the region.

In addition to these efforts, Hilton aims to minimize the use of disposable plastic materials by providing guests with compostable alternatives for straws, cups, and more.

For more resources, visit the Massport Recycling Sharepoint Page: http://sharepoint/CapitalPrograms/Sustainability/SitePages/Recycling.aspx

K

Peak Period Pricing Monitoring Reports

- 2017 Peak Period Pricing Monitoring Report
- 2018 Peak Period Pricing Monitoring Report
- 2019 Peak Period Pricing Monitoring Report
- Memorandum from Edward C. Freni, Massport Director of Aviation, to the Boston Airline Committee (BAC), Regarding Boston-Logan International Airport Peak Period Surcharge Regulation Monitoring Report. Dated June 5, 2019.

This Page Intentionally Left Blank.

BOSTON-LOGAN INTERNATIONAL AIRPORT MONITORING REPORT ON SCHEDULED AND NON-SCHEDULED FLIGHT ACTIVITY

Peak Period Surcharge Regulation
740 CMR 27:00: Massachusetts Port Authority

Report Number:	**014**
Monitoring Period:	**Through Sept. 2017**
Report Issue Date:	**May 2017**

<u>Note</u>: This report reflects the Boston-Logan Airport flight activity monitoring under 740 CMR 27.03 Peak Period Surcharge Regulation on Aircraft Operations at Boston-Logan International Airport.

<u>Findings</u>: This report includes actual and projected activity data **<u>through September 2017</u>**. Current and projected near-term flight levels at Boston Logan are well below Logan's good weather (VFR) throughput of approximately 120 flights per hour. **As a result, average VFR delays are projected to be minimal and well below the 15 minutes threshold through the analysis period.**

In the event demand conditions at the airport change significantly from the current projection, Massport will issue updates to this report.

<u>Attachments</u>

Table 1: Summary Overview of Peak Period Surcharge Program

Table 2: Summary Overview of Forecast Methodology

Table 3: Projected Aircraft Operations at Logan Airport Projected

Table 4: Projected Hourly Operations, Average Weekday

Table 5: Forecast Logan Average Weekday Operations

<u>Massport Contact:</u>

Mr. Flavio Leo
Director, Aviation Planning and Strategy
617-568-3528
fleo@massport.com

Table 1: Summary Overview of Peak Period Surcharge Program

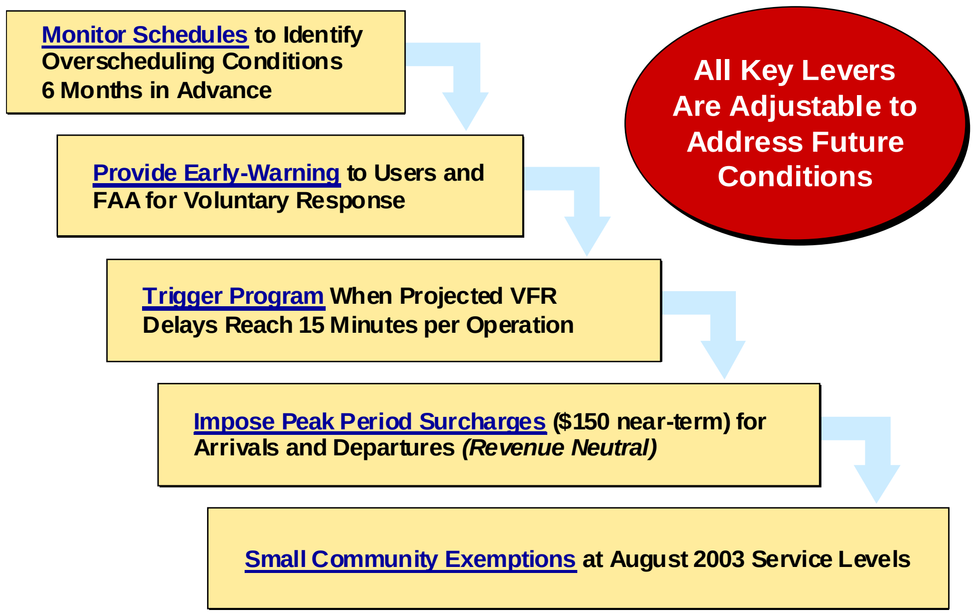


Table 2: Summary Overview of Forecast Methodology

- Scheduled passenger airline flights represent more than 93 percent of total aircraft operations. Passenger airline activity for the Spring and Summer periods were projected based on published advance airline schedules
- Forecasts of monthly activity for other segments (GA, Cargo, Charter) are based on the past three months of actual flight volume and historic patterns of monthly seasonality
- Day-of-week and time of day distributions for non-scheduled segments are based on analysis of Logan radar data
- Projections for each segment were combined to produce the forecast pattern of hourly flight activity for an average weekday, Saturday, and Sunday for the period from February through September

Table 3: Aircraft Operations at Logan Airport

Note: Actual Operations are based on Massport data/air carrier reports and reflect flight cancellations due to weather and other operational impacts.

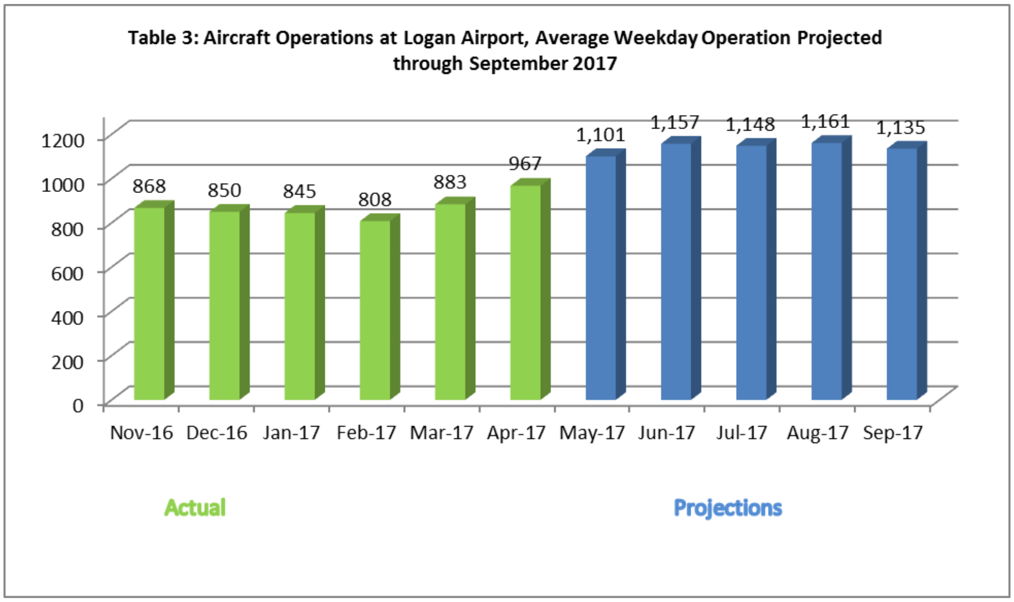


Table 4: Projected Hourly Operations

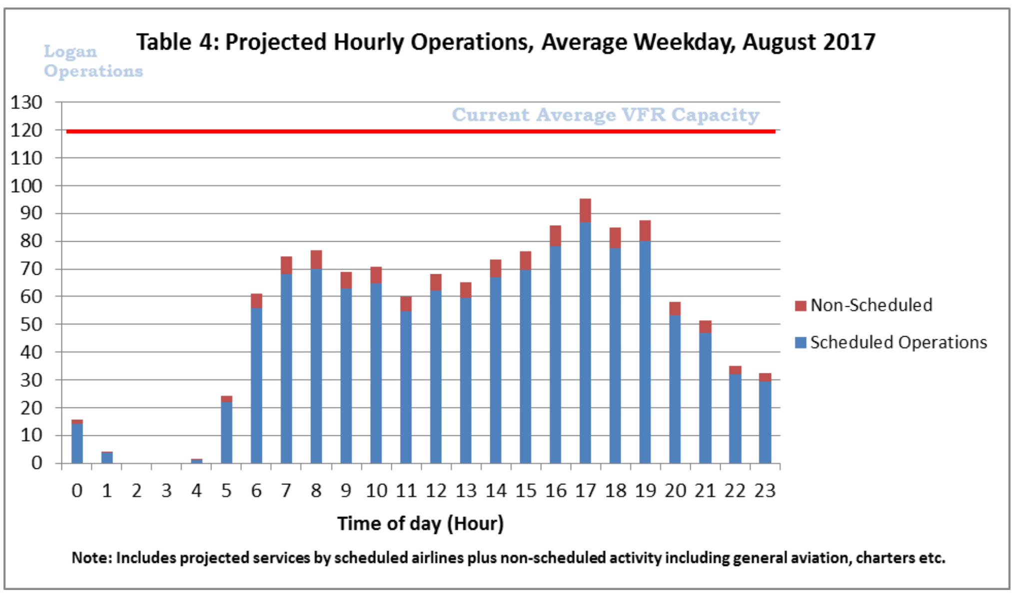


Table 5: Forecast Logan Average Weekday Operations, *Feb. – Sep.*

Forecast Daily Operations								
Hour Range	**Feb-17**	**Mar-17**	**Apr-17**	**May-17**	**Jun-17**	**Jul-17**	**Aug-17**	**Sep-17**
0	9	14	12	11	15	16	14	12
1	3	4	3	5	5	5	4	3
2	0	1	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0
4	2	2	0	0	0	0	1	1
5	12	17	18	21	27	30	22	18
6	39	47	54	53	55	52	56	52
7	46	49	61	64	66	66	68	76
8	44	47	80	67	67	64	70	66
9	45	52	66	64	65	63	63	65
10	43	47	48	62	68	66	65	58
11	44	43	53	50	52	53	55	56
12	37	39	55	60	62	62	62	62
13	41	45	56	63	61	57	59	65
14	42	45	57	63	68	68	67	63
15	48	50	62	66	70	67	70	62
16	57	55	70	78	77	82	78	79
17	57	58	83	77	87	86	87	87
18	52	59	79	74	75	69	78	78
19	51	56	67	77	82	81	80	75
20	48	52	55	43	48	52	53	48
21	40	41	36	44	47	46	47	45
22	27	34	26	34	35	33	32	33
23	20	25	31	25	28	28	30	29
Total	**808**	**883**	**1,071**	**1,101**	**1,157**	**1,148**	**1,161**	**1,135**

February - Apr are actual data

May - September is forecast data

BOSTON-LOGAN INTERNATIONAL AIRPORT MONITORING REPORT ON SCHEDULED AND NON-SCHEDULED FLIGHT ACTIVITY

Peak Period Surcharge Regulation
740 CMR 27:00: Massachusetts Port Authority

Report Number:	**015**
Monitoring Period:	**Through Sept. 2018**
Report Issue Date:	**May 2018**

<u>Note</u>: This report reflects the Boston-Logan Airport flight activity monitoring under 740 CMR 27.03 Peak Period Surcharge Regulation on Aircraft Operations at Boston-Logan International Airport.

<u>Findings</u>: This report includes actual and projected activity data **<u>through September 2018</u>**. Current and projected near-term flight levels at Boston Logan are well below Logan's good weather (VFR) throughput of approximately 120 flights per hour. **As a result, average VFR delays are projected to be minimal and well below the 15 minutes threshold through the analysis period.**

In the event demand conditions at the airport change significantly from the current projection, Massport will issue updates to this report.

<u>Attachments</u>

Table 1: Summary Overview of Peak Period Surcharge Program

Table 2: Summary Overview of Forecast Methodology

Table 3: Projected Aircraft Operations at Logan Airport Projected

Table 4: Projected Hourly Operations, Average Weekday

Table 5: Forecast Logan Average Weekday Operations

<u>Massport Contact:</u>

Mr. Flavio Leo
Director, Aviation Planning and Strategy
617-568-3528
fleo@massport.com

Table 1: Summary Overview of Peak Period Surcharge Program

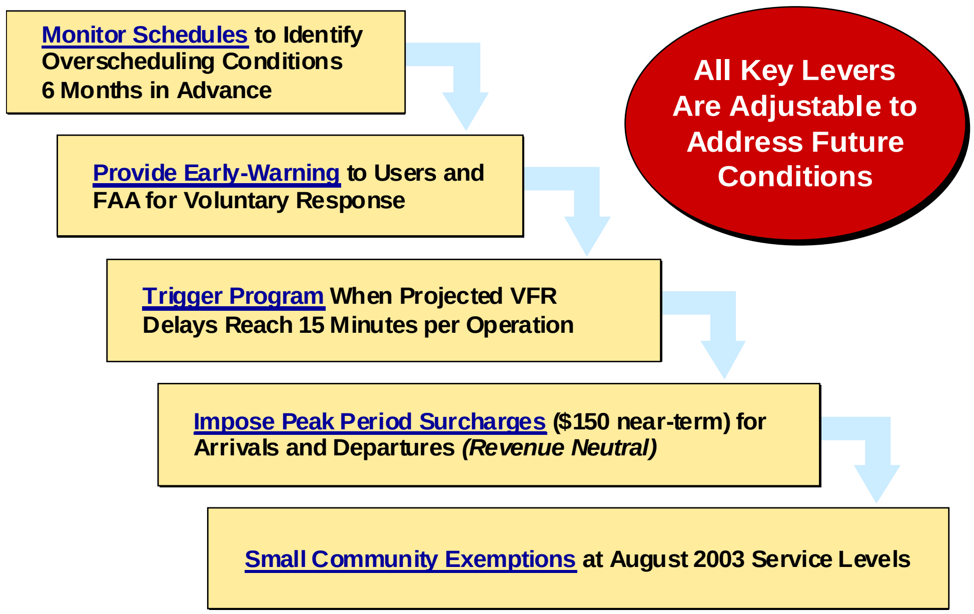


Table 2: Summary Overview of Forecast Methodology

- Scheduled passenger airline flights represent about 93 percent of total aircraft operations. Passenger airline activity for the Spring and Summer periods were projected based on published advance airline schedules
- Forecasts of monthly activity for other segments (GA, Cargo, Charter) are based on the past three months of actual flight volume and historic patterns of monthly seasonality
- Day-of-week and time of day distributions for non-scheduled segments are based on analysis of Logan radar data
- Projections for each segment were combined to produce the forecast pattern of hourly flight activity for an average weekday, Saturday, and Sunday for the period from February through September

Table 3: Aircraft Operations at Logan Airport

Note: Actual Operations are based on Massport data/air carrier reports and reflect flight cancellations due to weather and other operational impacts. Projections, scheduled activity only.

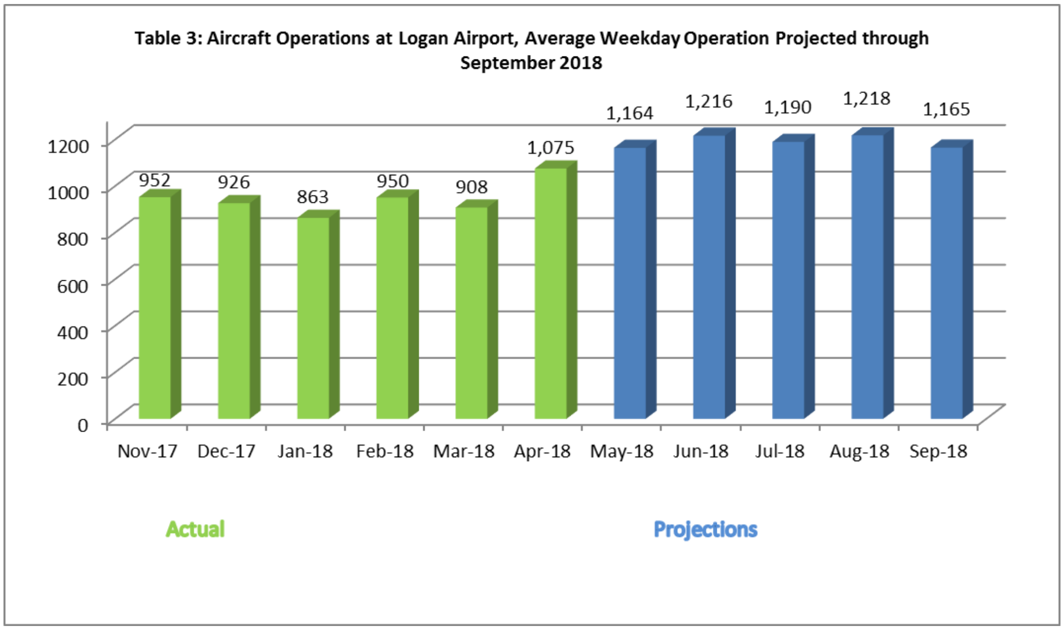


Table 4: Projected Hourly Operations

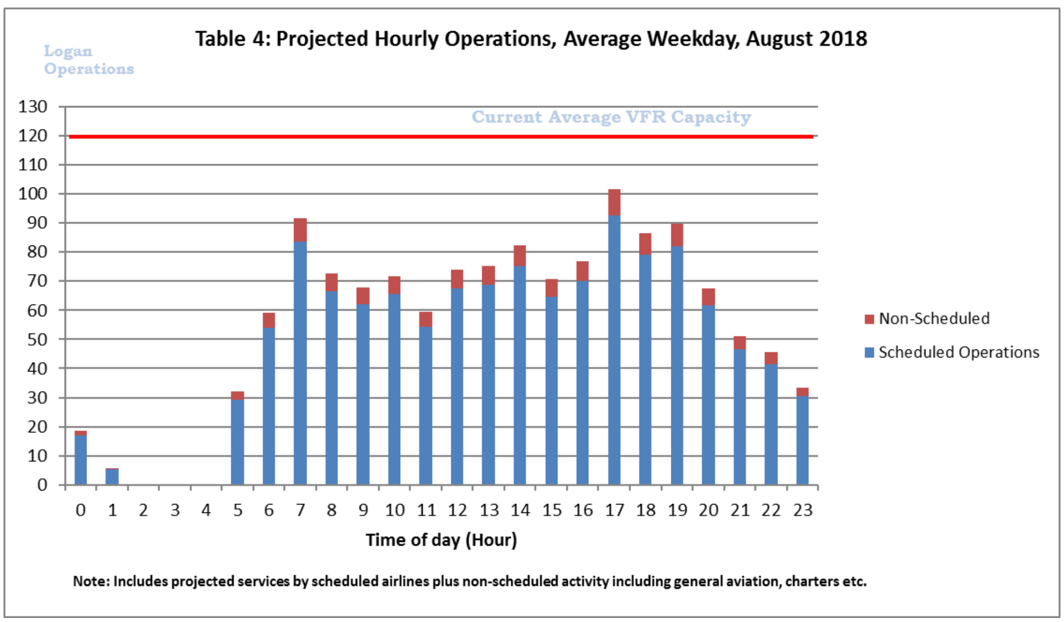


Table 5: Forecast Logan Average Weekday Operations, *Feb. – Sep.*

Forecast Daily Operations								
Hour Range	**Feb-18**	**Mar-18**	**Apr-18**	**May-18**	**Jun-18**	**Jul-18**	**Aug-18**	**Sep-18**
0	12	16	20	20	19	16	17	17
1	4	6	8	4	6	6	5	5
2	1	2	2	0	0	0	0	0
3	0	1	1	0	0	0	0	0
4	4	2	3	0	0	0	0	2
5	20	18	24	27	29	30	29	21
6	47	42	51	59	58	52	54	55
7	59	53	65	73	80	82	84	78
8	55	50	61	64	66	66	66	62
9	56	56	63	65	71	63	62	65
10	48	46	56	64	67	63	66	64
11	45	46	50	48	52	54	54	53
12	44	45	49	66	67	66	68	65
13	53	51	60	73	69	65	69	68
14	54	53	58	67	70	72	75	71
15	55	49	56	64	67	64	65	62
16	56	52	56	70	70	69	70	68
17	58	57	64	84	93	90	93	93
18	64	60	67	76	73	73	79	79
19	60	53	66	75	75	79	82	75
20	54	52	62	49	61	61	62	53
21	43	39	51	51	52	46	47	49
22	35	34	48	38	41	42	42	37
23	24	27	35	27	30	29	30	25
Total	**950**	**908**	**1,075**	**1,164**	**1,216**	**1,190**	**1,218**	**1,165**

February - April are actual data
May - September is forecast scheduled activity only

BOSTON-LOGAN INTERNATIONAL AIRPORT MONITORING REPORT ON SCHEDULED AND NON-SCHEDULED FLIGHT ACTIVITY

Peak Period Surcharge Regulation
740 CMR 27:00: Massachusetts Port Authority

Report Number:	**016**
Monitoring Period:	**Through Sept. 2019**
Report Issue Date:	**June 2019**

<u>Note</u>: This report reflects the Boston-Logan Airport flight activity monitoring under 740 CMR 27.03 Peak Period Surcharge Regulation on Aircraft Operations at Boston-Logan International Airport.

<u>Findings</u>: This report includes actual and projected activity data **<u>through September 2019</u>**. Current and projected near-term flight levels at Boston Logan are well below Logan's good weather (VFR) throughput of approximately 120 flights per hour. **As a result, average VFR delays are projected to be minimal and well below the 15 minutes threshold through the analysis period.**

In the event demand conditions at the airport change significantly from the current projection, Massport will issue updates to this report.

<u>Attachments</u>

Table 1: Summary Overview of Peak Period Surcharge Program

Table 2: Summary Overview of Forecast Methodology

Table 3: Projected Aircraft Operations at Logan Airport Projected

Table 4: Projected Hourly Operations, Average Weekday

Table 5: Forecast Logan Average Weekday Operations

<u>Massport Contact:</u>

Mr. Flavio Leo
Director, Aviation Planning and Strategy
617-568-3528
fleo@massport.com

Table 1: Summary Overview of Peak Period Surcharge Program

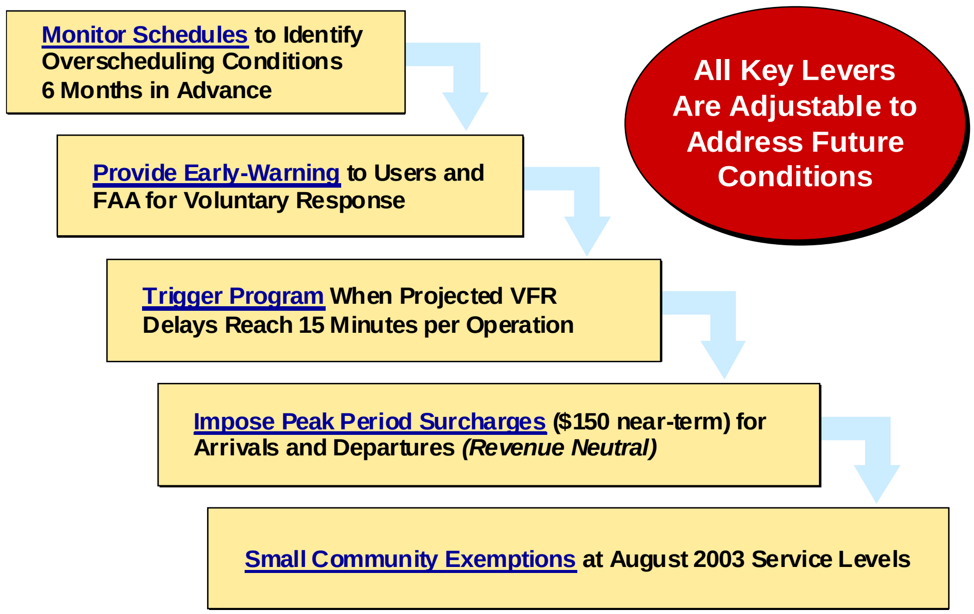


Table 2: Summary Overview of Forecast Methodology

- Scheduled passenger airline flights represent about 93 percent of total aircraft operations. Passenger airline activity for the Spring and Summer periods were projected based on published advance airline schedules
- Forecasts of monthly activity for other segments (GA, Cargo, Charter) are based on the past three months of actual flight volume and historic patterns of monthly seasonality
- Day-of-week and time of day distributions for non-scheduled segments are based on analysis of Logan radar data
- Projections for each segment were combined to produce the forecast pattern of hourly flight activity for an average weekday, Saturday, and Sunday for the period from February through September

Table 3: Aircraft Operations at Logan Airport

Note: Actual Operations are based on Massport data/air carrier reports and reflect flight cancellations due to weather and other operational impacts. Projections, scheduled activity only.

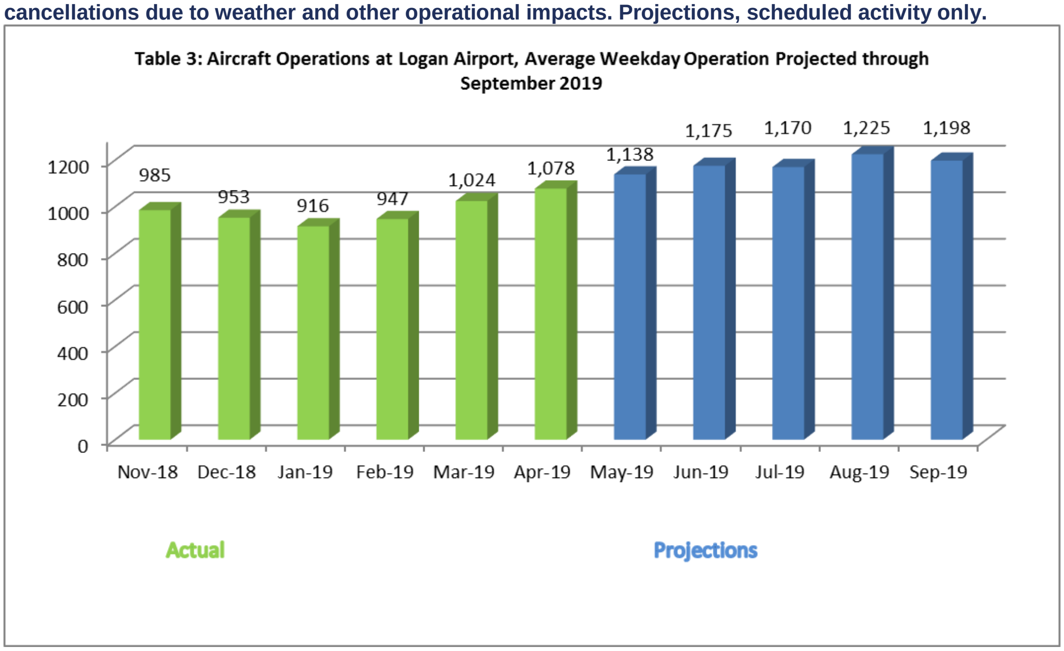


Table 4: Projected Hourly Operations

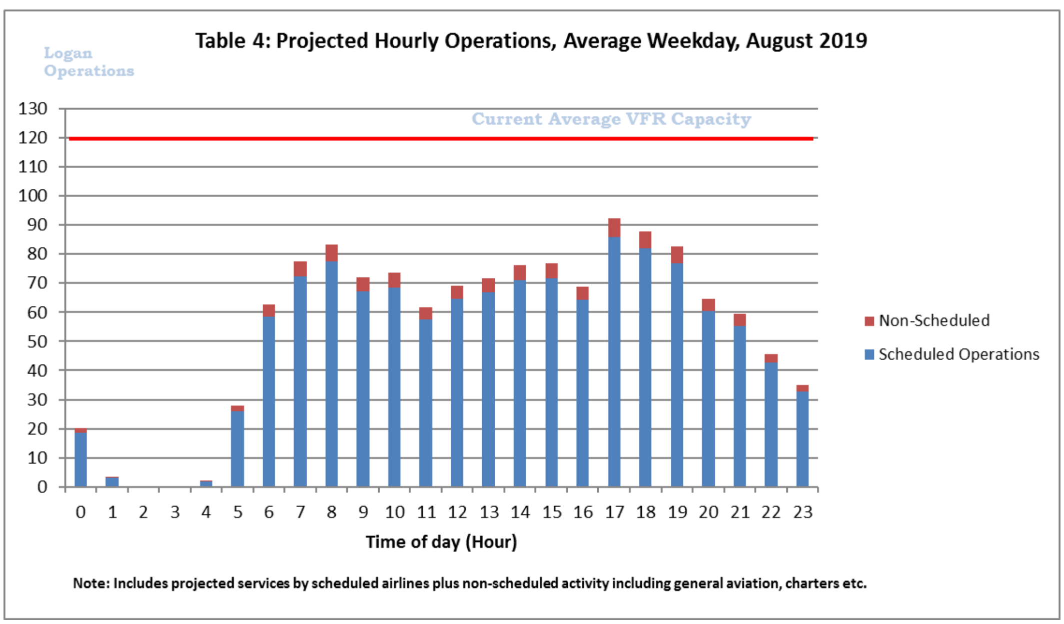


Table 5: Forecast Logan Average Weekday Operations, *Feb. – Sep.*

Forecast Daily Operations								
Hour Range	**Feb-19**	**Mar-19**	**Apr-19**	**May-19**	**Jun-19**	**Jul-19**	**Aug-19**	**Sep-19**
0	14	15	17	16	15	15	19	11
1	6	7	7	5	5	5	3	4
2	2	2	2	0	0	0	0	0
3	2	2	1	0	0	0	0	0
4	4	4	4	4	3	2	2	2
5	19	23	27	25	26	27	26	20
6	44	49	51	50	55	55	59	55
7	56	59	61	71	69	68	72	71
8	50	54	61	68	74	73	78	81
9	53	57	61	68	66	65	67	61
10	50	56	62	64	65	63	69	69
11	49	53	57	50	52	55	58	57
12	47	44	48	59	62	62	65	64
13	49	53	55	58	62	62	67	68
14	54	56	55	74	69	71	71	70
15	54	57	57	66	73	70	72	70
16	58	60	62	52	58	62	64	69
17	57	63	61	87	83	82	86	83
18	59	68	69	81	80	78	82	81
19	57	59	61	65	70	75	77	71
20	48	60	60	49	57	57	60	61
21	46	51	57	55	54	51	55	54
22	45	41	47	42	44	41	43	41
23	26	31	35	30	32	31	33	34
Total	**947**	**1,024**	**1,078**	**1,138**	**1,175**	**1,170**	**1,225**	**1,198**

February - Apr are actual data

May - September is forecast data

massport
Massachusetts Port Authority
One Harborside Drive
East Boston, MA 02128-2909
Telephone (617) 568-5000
www.massport.com

June 5, 2019

Boston Airline Committee (BAC)
c/o Kevin Costello
Director Infrastructure, Properties & Development
jetBlue Airways Corporation
27-01 Queens Plaza North
Long Island City, New York 11101

Re: Boston-Logan International Airport Peak Period Surcharge Regulation Monitoring Report

Dear Mr. Costello:

The Massachusetts Port Authority (Massport) has completed the Peak Period Pricing Monitoring Report for 2019, in compliance with Massport's Peak Period Surcharge Regulation (740 CMR 27.03) ("Regulation"). The Regulation requires that Massport monitor published scheduled and expected non-scheduled aircraft activity at Logan and report to airfield-users the implication of the total projected aircraft activity on Logan's good weather delays. I have attached a copy of the Monitoring Report.

The Monitoring Report includes historical and projected activity data for the 2019 spring and summer season. The report concludes that current and projected near-term flight levels at Boston-Logan are well below Logan's good weather (VFR) throughput of approximately 120 flights per hour. As a result, average VFR (good weather) delays based on the expected demand are projected to be minimal through the analysis period and well below the 15 minutes threshold of the Peak Period Surcharge Regulation.

Please forward a copy of this Monitoring Report to the BAC membership. If you have any questions please feel free to contact Flavio Leo at 617-568-3528 or Greg Zanni at 617-561-3372.

Sincerely,

Edward C. Freni
Director of Aviation

cc: Todd Smith, Daniel Gallagher, Greg Zanni, Flavio Leo

L

Reduced/Single Engine Taxiing at Logan Airport Memoranda

This Appendix provides detailed information in support of Chapter 7, *Air Quality/ Emissions Reduction:*

- Memorandum from Edward C. Freni, Massport Director of Aviation, to the Boston Logan Airline Committee, Regarding Single/Reduced-Engine Taxiing and Other Strategies to Reduce Aircraft-Generated Emissions and Noise at Boston Logan. Dated May 30, 2017.
- Memorandum from Edward C. Freni, Massport Director of Aviation, to the Boston Logan Airline Committee, Regarding Single/Reduced-Engine Taxiing and Other Strategies to Reduce Aircraft-Generated Emissions and Noise at Boston Logan. Dated May 22, 2018.
- Memorandum from Edward C. Freni, Massport Director of Aviation, to the Boston Logan Airline Committee, Regarding Update on Single/Reduced-Engine Taxiing and Other Strategies to Reduce Aircraft-Generated Emissions and Noise at Boston Logan. Dated June 12, 2019.

This Page Intentionally Left Blank.

massport
Massachusetts Port Authority
One Harborside Drive
East Boston, MA 02128-2909
Telephone (617) 568-5000
www.massport.com

TO: Boston Logan Air Carriers, Chief Pilots

FROM: Edward C. Freni
Director of Aviation

DATE: May 30, 2017

RE: Single/Reduced-Engine Taxiing and Other Strategies to Reduce Aircraft-Generated Emissions and Noise at Boston Logan

As an important user of Boston-Logan International Airport ("Boston Logan"), you are an essential partner in our efforts to ensure that Boston Logan operates in the safest, most dependable and environmentally responsible manner feasible. Our success in implementing physical and technological improvements and piloting cutting-edge safety enhancements at Boston Logan is based, in part, on continuing to evaluate and promote operational measures with the potential to reduce environmental impacts from various landside and airside operations.

Important measures that have been identified are:

1.) Single/reduced-engine taxiing,
2.) Use of idle-reverse thrust, and
3.) Retrofitting older A320 aircraft with "vortex generators" to reduce aircraft noise.

Based on outreach to the Logan air carrier community, it is clear that single- or reduced-engine taxiing is being voluntarily implemented by the vast majority of air carriers at Boston Logan. I write to you again to encourage your continued use of this fuel-saving emissions reduction strategy, subject to pilot discretion and to the extent consistent with your established operating safety procedures.

I also encourage your use of idle reverse thrust (or minimize the use of reverse thrust) on landing, as a second operational measure, again, only at the discretion of the pilot and only to the extent consistent with your established operational safety procedures. This measure provides noise relief to our nearest neighbors and, at the same time, provides companion benefits to you, such as reducing fuel burn and engine wear. Clearly, the use of this procedure must be consistent with operational conditions at Boston Logan, including runway surface conditions and whether LAHSO is in use.

Finally, I again want to share with you information regarding recent industry efforts to retrofit A320 aircraft with "vortex generators" to reduce airframe noise. Although the A320 is a fully noise-compliant/modern aircraft, this is an excellent example of additional, incremental actions we can take as an industry to reduce operational impacts on the environment. Attached please find more information related to this technology.

I encourage you to share this letter with your flight crews and thank you for your continued work to enhance Boston Logan's operational safety and efficiency, while improving its environmental footprint. If you have any questions or would like to discuss any aspect of this letter, please feel free to contact me or Mr. Flavio Leo, Director of Planning and Strategy, at 617-568-3528.

Edward C. Freni
Director of Aviation

Attachment

An even quieter approach: Airbus introduces air flow deflectors on the A320 Family

10 JULY 2014 NEWS IN BRIEF

Building on the A320 Family's established reputation for quiet operations, Airbus is reducing noise levels even further for its popular single-aisle product line with the introduction of small underwing air flow deflectors. Positioned just ahead of underwing cavities for the fuel over-pressure protection system, these devices prevent the cavities from generating a "whistling" sound which can sometimes be heard on the ground when the engines are at idle during final approach. Air flow deflectors were implemented in production A320 jetliners this spring and are also available as a retrofit modification.

Tags : INNOVATION A320 FAMILY NOISE

Massachusetts Port Authority
One Harborside Drive
East Boston, MA 02128-2909
Telephone (617) 568-5000
www.massport.com

To: Boston Airline Committee

From: Edward C. Freni
Director of Aviation

Date: May 22, 2018

RE: Single/Reduced-Engine Taxiing and Other Strategies to Reduce Aircraft-Generated Emissions and Noise at Boston Logan

As an important user of Boston-Logan International Airport ("Boston Logan"), you are an essential partner in our efforts to ensure that Boston Logan operates in the safest, most dependable and environmentally responsible manner. Although the aviation industry has been highly successful in reducing noise and emissions, there are additional opportunities to further reduce aircraft noise and emissions including: 1. Single/reduced-engine taxiing, 2. Use of idle-reverse thrust, and 3. Retrofitting older A320 aircraft with "vortex generators" to reduce aircraft noise.

We understand that single or reduced-engine taxiing is being voluntarily implemented by the vast majority of air carriers at Boston Logan. I write to you to encourage your continued use of this fuel-saving emissions reduction strategy, subject to pilot discretion and to the extent consistent with your established operating safety procedures.

I also encourage your use of idle reverse thrust (or to minimize the use of reverse thrust) on landing, as a second operational measure, again, only at the discretion of the pilot and consistent with your established operational safety procedures. This measure provides noise relief to our nearest neighbors and, at the same time, provides companion benefits to you, such as reducing fuel burn and engine wear. Clearly, the use of this procedure must be consistent with operational conditions at Boston Logan, including runway surface conditions and whether LAHSO is in use.

Finally, I urge you to continue recent industry efforts to retrofit A320 family aircraft with "vortex generators" to reduce airframe noise unique to this aicraft. Although the A320 is a fully noise-compliant/modern aircraft, this is an excellent example of additional, incremental actions we can take as an industry to reduce impacts on the environment. Attached please find more information related to this technology.

Thank you for your continued work to enhance Boston Logan's operational safety and efficiency, while improving its environmental footprint. If you have any questions or would like to discuss any aspect of this letter, please feel free to contact me or Mr. Flavio Leo, Director of Planning and Strategy, at 617-568-3528.

Edward C. Freni
Director of Aviation

Attachment

An even quieter approach: Airbus introduces air flow deflectors on the A320 Family

Building on the A320 Family's established reputation for quiet operations, Airbus is reducing noise levels even further for its popular single-aisle product line with the introduction of small underwing air flow deflectors. Positioned just ahead of underwing cavities for the fuel over-pressure protection system, these devices prevent the cavities from generating a "whistling" sound which can sometimes be heard on the ground when the engines are at idle during final approach. Air flow deflectors were implemented in production A320 jetliners this spring and are also available as a retrofit modification.

Massachusetts Port Authority
One Harborside Drive
East Boston, MA 02128-2909
Telephone (617) 568-5000
www.massport.com

To: Boston Airline Committee

From: Edward C. Freni
Director of Aviation

Date: June 12, 2019

RE: Update on Single/Reduced-Engine Taxiing and Other Strategies to Reduce Aircraft-Generated Emissions and Noise at Boston Logan

As an important user of Boston-Logan International Airport ("Boston Logan"), you are an essential partner in our efforts to ensure that Boston Logan operates in the safest, most dependable and environmentally responsible manner. Although the aviation industry has been highly successful in reducing noise and emissions, there are additional opportunities to further reduce our environmental footprint.

One action air carriers are taking to reduce noise is the retrofitting of the A320 family of aircraft to reduce airframe noise. I want to congratulate jetBlue in their announcement to retrofit their A320s aircraft with "vortex generators" to reduce airframe noise unique to this airplane type (see attachment). This initiative will provide meaningful reductions in noise that generates community complaints. If your airline is also working towards this retrofit please let us know. I strongly urge you to consider this important improvement to the noise emissions of this family of aircraft.

I understand that single or reduced-engine taxiing is being voluntarily implemented by the vast majority of air carriers at Boston Logan. I write to you to encourage your continued use of this fuel-saving emissions reduction strategy, subject to pilot discretion and to the extent consistent with your established operating safety procedures.

Finally, I encourage your use of idle reverse thrust (or to minimize the use of reverse thrust) on landing, as a second operational measure, again, only at the discretion of the pilot and consistent with your established operational safety procedures. This measure provides noise relief to our nearest neighbors and, at the same time, provides companion benefits to you, such as reducing fuel burn and engine wear. The use of this procedure must be consistent with operational conditions at Boston Logan, including runway surface conditions and whether LAHSO is in use.

Thank you for your continued work to enhance Boston Logan's operational safety and efficiency, while improving its environmental footprint. If you have any questions or would like to discuss any aspect of this letter, please feel free to contact me or Mr. Flavio Leo, Director of Planning and Strategy, at 617-568-3528.

Attachment

JetBlue has committed to add vortex generators to its 138 remaining Airbus A320 family aircraft through 2021

East Boston
TIMES-FREE PRESS

Page 10 THE EAST BOSTON TIMES-FREE PRESS Wednesday, October 17, 2018

Massport and community applaud JetBlue's plans to retrofit airbus fleet with noise reducing generators

Special to the Times

Last week, JetBlue announced plans to retrofit their entire Airbus fleet with noise-reducing vortex generators. JetBlue is the largest operator at Logan International Airport and this move reflects the partnership between Massport and the airline to reduce aircraft noise to benefit surrounding communities. Massport understands concerns about aircraft noise and has continuously been involved in community discussions with residents and elected officials regarding overflights.

"While the airline industry has benefited from advances in technology and efficiency leading to quieter planes and engines, the work is never done," said Joe Bertapelle, Director Strategic Airspace Programs, JetBlue. "We're pleased to incorporate this advancement across our Airbus fleet and contribute to our communities in a meaningful way as good corporate citizens."

Beginning in 2015, the airline began taking delivery of new aircraft with vortex generators already installed as standard equipped Airbus family aircraft. JetBlue is committing to add the devices to its 138 remaining Airbus A320 family aircraft through 2021. The small devices disrupt wind over ports on the wing which can produce a "whistling" tone during approach into an airport.

Vortex generators will be installed on 130 existing JetBlue A320 aircraft and 8 JetBlue A321 aircraft during their existing scheduled heavy checks with the full fleet wide install expected to be complete in 2021. All future Airbus orders will be delivered with vortex generators already installed.

This extraordinary commitment is a testament to years of advocacy by local elected officials, and JetBlue's ongoing support for the communities where its customers and crewmembers live and work paralleled JetBlue's own research on the effectiveness of vortex generators.

"Thank you to JetBlue for its leadership in implementing noise-reduction technologies to its entire Airbus fleet," said House Speaker Robert DeLeo. "I'm encouraged that the airline is taking this important step on this issue- one I have advocated for since I was a municipal official. I encourage the other airlines that fly in and out of Logan Airport to follow JetBlue's example."

Working with the community and elected officials, Massport has made efforts over the years in various areas to mitigate the effects of aircraft noise. Currently, Massport and the FAA are working on a groundbreaking RNAV Study led by technical experts at MIT to develop test projects to determine the possibility of noise reducing procedures at Logan. Working with the public and the statutorily created Massport Community Advisory Committee (Massport CAC), Massport has completed an initial phase called Block 1 and are in Block 2. Block 1 resulted in recommendations, which were technically less complex and did not result in shifting of noise from one community to another. Block 2 is looking at ideas that are more complex and that may shift noise.

"JetBlue's new technology to reduce airplane noise will have a positive impact on the communities impacted by flights arriving at Logan," said Senator Joseph Boncore. "This is a great move for the airline and a win for those who have advocated on this issue over the years."

"I'm pleased with JetBlue's efforts to implement noise-reduction technology across its Airbus fleet," Rep. Adrian Madaro said. "Noise pollution has long been a top quality of life concern for residents of East Boston. This investment is a step in the right direction and I implore other airlines to make noise reduction a priority as well."

The Massport CAC spearheaded that Massport prioritize this noise reduction implementation.

In December of 2015, East Boston resident John Nucci was named by Boston Mayor Marty Walsh as a representative of the City of Boston to the Massport CAC. That committee unanimously elected him as their appointment to the Massport Board of Directors.

"As a lifelong resident of East Boston, I know how important it is that Massport push the airlines to develop noise reducing benefits for the surrounding communities," said Massport CAC member and Board member John Nucci. "After hearing from the membership of the Massport CAC, as their appointment to the Massport Board, I was pleased to advocate for the retrofit of fleets to include noise-reducing vortex generators. JetBlue's actions are a positive outcome for all."

"At Massport, we are continuously engaged with the surrounding communities of Logan Airport and appreciate their feedback regarding airplane noise," said Massport CEO Thomas P. Glynn. "We think this is a great step JetBlue is taking toward reducing airplane noise and we are thankful to the airline for making this a priority."

"After hearing from the membership of the Massport CAC, as their appointment to the Massport Board, I was pleased to advocate for the retrofit of fleets to include noise-reducing vortex generators. JetBlue's actions are a positive outcome for all."

jetBlue

JetBlue to Retrofit Airbus Fleet with Vortex Generators

Oct 10, 2018

NEW YORK--(BUSINESS WIRE)-- JetBlue (NASDAQ: JBLU), New York's Hometown Airline™, today announces plans to retrofit its entire Airbus fleet with noise-reducing vortex generators. This move reflects JetBlue's continued commitment to the communities where its customers and crewmembers live and work. Beginning in 2015, JetBlue began taking delivery of new aircraft with vortex generators already installed. JetBlue is committing to add the devices to its 138 remaining Airbus A320 family aircraft through 2021. The small devices disrupt wind over ports on the wing which can produce a "whistling" tone during approach into an airport.

"While the airline industry has benefited from advances in technology and efficiency leading to quieter planes and engines, the work is never done," said Joe Bertapelle, Director Strategic Airspace Programs, JetBlue. "We're pleased to incorporate this advancement across our Airbus fleet and contribute to our communities in a meaningful way as good corporate citizens."

Vortex generators will be installed on 130 existing JetBlue A320 aircraft and eight JetBlue A321 aircraft during their existing scheduled heavy checks with the full fleet wide install expected to be complete in 2021. All future Airbus orders will be delivered with vortex generators already installed. The cost to retrofit the full Airbus fleet is less than $1 million.

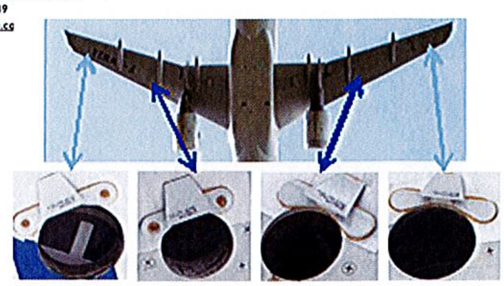
About JetBlue

JetBlue is New York's Hometown Airline®, and a leading carrier in Boston, Fort Lauderdale - Hollywood, Los Angeles (Long Beach), Orlando, and San Juan. JetBlue carries more than 40 million customers a year to 103 cities in the U.S., Caribbean, and Latin America with an average of 1,000 daily flights. For more information please visit www.jetblue.com.

View source version on businesswire.com: https://www.businesswire.com/news/home/20181010005816/en/

JetBlue Corporate Communications
Tel: +1.718.709.3089
corpcomm@jetblue.cc

Source: JetBlue



This Page Intentionally Left Blank.